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(54) CLOTH AND CLOTH PRODUCT TO BE BROUGHT DIRECTLY IN TOUCH WITH HUMAN SKIN

(57) The present invention provides a fabric which is prepared from filamentary material. The fabric according to the present invention is preferably used for an undergarments and, shows excellent sweat absorbability, gives a cool and refreshing feeling in summer, is soft to the touch and warm in winter, exhibits excellent stretchability and smoothness, produces decreased physical frictional irritation to the skin and a comfortable wearable feeling, and maintains an aesthetic appearance.

The fabric of the present invention comprises a knitted or woven fabric obtained by knitting or weaving a composite crimped yarn prepared by combining cellulose multifilaments and synthetic fiber multifilaments at least one of which are false twisted, and satisfying the following requirements (a) to (e):

(a) the mixing ratio of the cellulose multifilaments in the composite crimped yarn is from 15 to 85% by weight;
(b) the total size of the composite crimped yarn is from 44 to 333 dtex;
(c) the single filament size of the cellulose multifilaments is from 0.1 to 5.6 dtex;
(d) the single filament size of the synthetic fiber multifilaments is from 0.1 to 5.6 dtex; and
(e) the crimp stretchability of the composite crimped yarn is greater than 4.0% and 35% or less.

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Description

Technical Field

[0001] The present invention relates to a fabric and, in more detail, to a fabric to be worn directly on the skin, for which a composite crimped yarn prepared by combining and false twisting cellulose multifilaments and synthetic fiber multifilaments is used, which particularly gives an excellent wearable feeling and has an aesthetic appearance when used for undergarments and which is appropriate for men's undergarments, and to fabric products in which the fabric is used.

Background Art

[0002] Clothing, etc. to be worn directly on the skin, and undergarments in particular, are required to have various functions. Of the functions, the following are important, for the undergarments, to make the wearer feel comfortable: an undergarment excellent in sweat absorbability without becoming sticky; an undergarment excellent in moisture absorbability and having less sweaty-sticky feeling; an undergarment having a soft touch; an undergarment excellent in stretchability without giving a constrained feeling during movement; and an undergarment excellent in smoothness and giving a comfortable wearable feeling. Moreover, it is also an important function of an undergarment to be less irritating to the skin and more gentle even when it is repeatedly worn.

[0003] Of undergarments, men's undergarments are required to have particularly excellent functions. That is, men perspire more, on average, in comparison with women and wear an undergarment under a shirt and a jacket. The undergarment therefore must adequately cope with a large amount of sweat and it is required to have significantly high sweat absorbability. Moreover, since the undergarment is repeatedly worn everyday over many years, it is required to be less irritating to the skin. Moreover, the undergarments are desired to be excellent in stretchability, give no constrained feeling during wearer's action, and have a smooth feeling and a comfortable wearable feeling. Furthermore, spun yarn materials mainly prepared from a material containing 100% of cotton have been principally used for men's undergarments from the standpoint of stressing the above functions. The above spun yarn materials have been used because it has been impossible to obtain satisfactory undergarments, having more excellent functions than cotton, from filament materials.

[0004] Generally speaking, filament materials have excellent properties, which spun yarn materials do not have, such as specific luster and an aesthetic appearance, and they also have excellent functional properties that can be utilized for men's undergarments. However, the filament materials have not been used as men's undergarments for reasons explained below.

[0005] That is, clothing composed of cellulose multifilaments is characterized in that it is excellent in moisture absorption, luster and touch. However, when its wearer perspires a lot, the sweat amount exceeds the allowable amount of the materials, and the clothing holding water clings to the skin to make the wearer feel uncomfortable. Moreover, the clothing has the following disadvantages: repeated washing of the clothing makes it have a hard feeling compared with that in the initial state; the wet clothing is poor in dimensional stability; the clothing tends to wrinkle in the process of being wetted and dried; and the clothing has a low wet strength.

[0006] On the other hand, clothing composed of hydrophobic synthetic fiber multifilaments is excellent in dimensional stability and wet strength, and shows little change in a feeling when washed. However, the clothing gives its wearer a significantly sweaty, sticky feeling because it has insufficient moisture absorbability. Of clothing composed of hydrophobic synthetic fiber filaments, part of it sometimes produces a micro-frictional irritation to the keratin cells as a result of pressing, shifting, rubbing and the like between the clothing and the skin when it is worn. Consequently, the wearer sometimes has a portion of the skin that becomes red, and an unfamiliar feeling. In particular, a wearer having xerosis sometimes feels itchy in winter.

[0007] Furthermore, clothing composed of materials prepared of false-twist, crimped, modified cross-section, hydrophobic, synthetic-fiber multifilaments, and knitting or weaving the resultant texturized products, and by subjecting the knitted or woven fabric to chemical treatment for water absorption has the following advantages: it is excellent in sweat absorbability; it dries rapidly; and it does not become sticky with sweat. However, the clothing is less excellent in moisture absorbability (properties preventing sweaty, sticky feeling) and has a decreased tendency toward irritating the skin than clothing prepared from cotton or cellulose multifilaments.

[0008] Furthermore, clothing prepared from a combined composited yarn in which cellulose multifilaments and synthetic fiber multifilaments are combined has been developed. Such clothing gives a luster that cellulose multifilaments and synthetic multifilaments have, and a unique aesthetic appearance different from a spun yarn. However, as to the function, the clothing has not solved the problem that the clothing clings to the skin when the wearer perspires a lot. In particular, it has no satisfactory excellent function as men's undergarments.

[0009] As explained above, an undergarment having the following excellent properties has not been obtained in the

field: an undergarment neither becoming sticky nor clinging to the skin when the wearer perspires very much in ordinary life, while maintaining an aesthetic appearance the filament materials have; an undergarment excellent in stretchability and not constraining the wearer during wearer's action; an undergarment excellent in smoothness, and giving the wearer a comfortable wearable feeling; an undergarment producing a frictional irritation to the skin to a decreased degree during wearer's action; and an undergarment gentle to the skin even when it has been repeatedly worn everyday over many years.

[0010] Furthermore, when attention is paid to the function of being gentle to the skin, of clothing materials, it is understood that the irritation to the human skin include a chemical irritation caused by a chemical component and a physical irritation caused by a physical frictional irritation. The method of evaluating a chemical irritation of clothing materials by a so-called patch test has heretofore been widely known. Clothing materials showing fewer skin irritating properties have heretofore been developed in the direction toward not using a chemical component that shows chemically irritating properties, on the basis of the evaluation method. However, there has been no method of quantitatively evaluating a physical irritation to the skin of clothing materials. Therefore, there has currently been no clothing that has been developed by paying attention to a physical irritation to the skin. Actually, many kinds of irritation to the skin that appear to be caused by physical irritation of clothing materials and that include indispositions such as the skin becoming itchy and the skin becoming red during perspiration have been observed.

Disclosure of the Invention

[0011] An object of the present invention is to solve the above problems associated with the prior art, and provide a fabric or fabric product to be worn directly on the skin prepared from filamentary materials, appropriate as men's undergarments, etc., and having the following advantages: it particularly neither gives a sticky feeling nor clings to the skin even when the wearer perspires; it is excellent in moisture absorbability and it is less sweaty-sticky feeling; it is cool and refreshing even on a hot summer day; it has a soft touch and is warm even on a cold winter day; moreover, it is excellent in stretchability and smoothness, and gives no restrained feeling and a comfortable wearable feeling during wearer's movement; furthermore, it gives less physical frictional irritation to keratin cells of the skin; it is gentle to the skin even when repeatedly worn everyday over many years; and it is excellent in appearance.

[0012] In view of the above object, the present inventors have intensively carried out investigations for the purpose of obtaining a fabric or a fabric product to be worn directly on the skin which is excellent in functionality and has a beautiful appearance, and for which filament materials are used. As a result, they have developed materials to be in direct contact with skin which do not become sticky even when the wearer perspires, which give less physical friction irritation to the skin, for which filament materials are used, and which are excellent in wearable properties by using (1) a wet frictional coefficient obtained by evaluating a frictional coefficient of clothing materials having absorbed water (the evaluation method, etc. will be explained later) and (2) a skin irritation index obtained by the method of evaluating physical irritation of the clothing materials for the skin (the evaluation method, etc. will be explained later), the present inventors proposing the coefficient in (1) and the index in (2).

[0013] That is, the present invention is as explained below.

1. A fabric to be worn directly on the skin comprising a knitted or woven fabric obtained by knitting or weaving a composite crimped yarn prepared by combining cellulose multifilaments and synthetic fiber multifilaments at least one of which are false twisted, and satisfying the following requirements (a) to (e):

   (a) the mixing ratio of the cellulose multifilaments in the composite crimped yarn is from 15 to 85% by weight;
   (b) the total size of the composite crimped yarn is from 44 to 333 dtex;
   (c) the single filament size of the cellulose multifilaments is from 0.1 to 5.6 dtex;
   (d) the single filament size of the synthetic fiber multifilaments is from 0.1 to 5.6 dtex; and
   (e) the crimp stretchability of the composite crimped yarn is greater than 4.0% and 35% or less.

2. The fabric according to 1 mentioned above, wherein the crimp stretchability of the composite crimped yarn is from 8.0 to 25%.

3. The fabric according to 1 or 2 mentioned above, wherein the knitted or woven fabric shows a wet frictional coefficient of 3.0% or less.

4. The fabric according to any one of 1 to 3 mentioned above, wherein the ratio (A) of S to SG is from 30 to 95%, wherein S is the area of the duplicating region of the dispersion region of the single filaments in the cellulose multifilaments and the dispersion region of the single filaments in the synthetic fiber multifilaments, and SG is the area of the dispersion region of single filaments in the synthetic fiber multifilaments.

5. The fabric according to any one of 1 to 4 mentioned above, wherein SB that is defined by the formula (2) and that is a measure of a cool and refreshing feeling in a slightly sweaty environment of the knitted or woven fabric

satisfies the formula (1), and SN that is defined by the formula (4), which is a measure of a cool and refreshing feeling when the wearer perspires, satisfies the formula (3):

$$0.0 < SB < 100.0 \quad (1)$$

$$SB = 1.08 \times (\text{heat dissipation amount}) + 1.98 \times (\text{surface unevenness}) + 6.25 \times (\text{surface frictional coefficient}) - 13.92 \quad (2)$$

$$0.0 < SN < 100.0 \quad (3)$$

$$SN = -0.03 \times (\text{water transport amount}) + 1.42 \times (\text{moisture transfer degree}) + 0.17 \times (\text{heat dissipation amount}) + 0.76 \times (\text{surface unevenness}) + 12.1 \times (\text{surface frictional coefficient}) - 16.6 \quad (4)$$

6. The fabric according to any one of 1 to 5 mentioned above, wherein the knitted or woven fabric shows a skin irritation index of 8.0 μS or less during drying.

7. The fabric according to any one of 1 to 6 mentioned above, wherein the stretch stress of the knitted fabric in the warp direction during stretching by 50% and the stretch stress thereof in the weft direction during stretching by 80% are 20 cN/cm width or less, and the stretch recovery ratio of the knitted fabric in the warp direction during stretching by 50% and the stretch recovery ratio thereof in the weft direction during stretching by 100% are 80% or more.

8. The fabric according to any one of 1 to 7 mentioned above, wherein the knitted fabric is composed of an interlock texture having a mass per unit area of 80 to 250 g/m^2, and the loop length L (cm) of stitches forming the knitted fabric and the total size D (dtex) of the composite crimped yarn satisfy the formula (5):

$$2.9\ (\text{cm}) \leqq (L/D^{1/2}) \times 100 \quad (5)$$

9. The fabric according to any one of 1 to 7 mentioned above, wherein the knitted fabric is composed of a circular rib texture having a mass per unit area from 80 to 250 g/m^2, and the loop length L (cm) of stitches forming the knitted fabric and the total size D (dtex) of the composite crimped yarn satisfy the formula (6):

$$2.1\ (\text{cm}) \leqq (L/D^{1/2}) \times 100 \quad (6)$$

10. The fabric according to any one of 1 to 7 mentioned above, wherein the knitted fabric is composed of a gray sheeting texture having a mass per unit area from 80 to 250 g/m^2, and the loop length L (cm) of stitches forming the knitted fabric and the total size D (dtex) of the composite crimped yarn satisfy the formula (7):

$$2.1\ (\text{cm}) \leqq (L/D^{1/2}) \times 100 \quad (7)$$

11. A fabric product in which the fabric according to any one of 1 to 10 mentioned above is entirely or partly used for a garment, bedding, a towel or a handkerchief.

12. An undergarment for which the fabric according to any one of 1 to 10 mentioned above is entirely or partly used.

[0014] The present invention will be explained below in detail.

[0015] First, the sweat absorption mechanism of a fabric in direct contact with skin will be explained.

[0016] There are the following five factors important to prevent the fabric from becoming sticky and clinging to the skin when the wearer perspires.

[0017] First, it is important for the fabric to absorb sweat on the skin as soon as possible. Second, when the wearer continues to perspire, the fabric continues to absorb the sweat, and finally the sweat held by the fabric exceeds the allowable amount. As a result, a water film is formed on the fabric (the water-retention capacity at the time of forming a water film being referred to as a critical water-retention capacity hereinafter), and sweat remains on the skin. The fabric itself thus becomes sticky with sweat. In order to avoid such a situation, it is important that the fabric have a high critical water-retention capacity so that the perspiration amount during wearing is within the capacity. Third, when the fabric is pressed by wearer's movement, it is important that the sweat absorbed to the fabric does not ooze out on the fabric even if the fabric is compression deformed. When the fabric is compression deformed to crush air gaps by wearer's pressure, air gap water tends to ooze out, whereas bound water hardly oozes out. Fourth, when the change with time of the fabric in a worn state is viewed, excellent quick drying properties of the fabric have the effect of substantially raising the critical water-retention capacity. Fifth, when the perspiration amount is significantly large and the sweat amount reaches the critical water-retention capacity to form a water film on the fabric surface, it is important to make the area of water film, that is contacted with the skin, small.

[0018] In addition, the water-retention capacity of a fabric is a total of an amount of water held by the yarn as bound water and an amount of water held in air gaps among the yarns as air gap water.

[0019] The knitted or woven fabric (hereinafter merely referred to as a knitted fabric, and the like, sometimes) used as the fabric of the present invention is prepared by combining cellulose multifilaments and synthetic fiber multifilaments, and the former and/or the latter multifilaments are a false twisted composite crimped yarn. Moreover, the knitted or woven fabric of the present invention is satisfactory so long as the composite crimped yarn is at least partly used therefor. For example, a knitted or woven fabric obtained by further plaiting, knitting or weaving other fiber materials is also included.

[0020] In the present invention, the composite crimped yarn has a structure wherein cellulose multifilaments and synthetic fiber multifilaments are mixed with each other while the single filament arrangement is disordered, and many air gaps remain within the yarn due to the crimping. The composite crimped yarn is satisfactory so long as at least one of the former and the latter multifilaments are false twisted. When both are false twisted, the composite crimped yarn has the following preferable structure. Many single filaments of the synthetic fiber multifilaments are substantially present near the surface of the composite crimped yarn, and many single filaments of the cellulose multifilaments are present in the central portion because the single filaments of the cellulose multifilaments tend to be relatively weakly crimped and because the single filaments of the synthetic fiber multifilaments tend to be relatively strongly crimped.

[0021] The fabric of the invention therefore seldom has sweaty, sticky feeling and makes the wearer feel comfortable, even on a day with high humidity, due to the excellent moisture absorbability of the cellulose multifilaments. Moreover, the fabric can hold moisture of absorbed sweat as bound water of the cellulose multifilaments, and can hold a large amount of moisture as air gap water in air gaps among single filaments increased by crimping the texturized yarn and in air gaps among loops (when the fabric is a knitted one). The fabric is thus greatly increased in critical water-retention capacity.

[0022] Furthermore, since the fabric holds sweat as bound water of the cellulose, the sweat hardly oozes out from the fabric when wearing pressure is applied. Moreover, since cellulose multifilaments and synthetic fiber multifilaments are mixed with each other in the fabric, the diffusion rate of sweat in the yarn and fabric is high due to the mutual effects. As a result, the fabric shows a high drying rate, and the substantial critical water-retention capacity of the fabric becomes still larger. Moreover, sweat absorbed from the skin surface is gradually transferred to the central portion of the yarn, with time, to be localized; the presence of hydrophobic synthetic fiber multifilament single filaments that are projected out in a gently curved shape from the surface of the yarn and that has a small water-retention capacity produces spacer effects between the skin and the moisture within the yarn to prevent the fabric from becoming sticky.

[0023] The crimp stretch ratio of the composite crimped yarn used in the present invention is an index of a crimping degree, and is very strongly related to various functions of a fabric to be in direct contact with skin, which is an object of the present invention. That is, when the crimp stretch ratio of a fabric is large, the stretchability of the fabric increases. Moreover, for a composite crimped yarn in particular, the crimp stretch ratio reflects such factors as the disorder degree in the single filament arrangement of the single filaments in cellulose multifilaments and those of synthetic fiber multifilaments, the mixing degree of single filaments and the air gap amount within the composite crimped yarn. Accordingly, when the crimp stretch ratio of the composite crimped yarn is too small, the sweat-treating function by the above mechanism cannot be achieved. Moreover, for the composite crimped yarn, since the crimp stretch ratio reflects the disorder degree of the single filament arrangement of synthetic fiber multifilaments, as explained above, the irritation to the skin becomes strong when the crimp stretch ratio becomes excessively high due to the physical irritation caused by single filaments of the synthetic fiber multifilaments, and the skin and hand touches tend to become poor.

[0024] For the composite crimped yarn used in the present invention, the ratio (A) of S to SG, wherein S is an area of the duplicating region of the dispersion region of the single filaments in the cellulose multifilaments and the dispersion region of the single filaments in the synthetic fiber multifilaments, and SG is an area of the dispersion region of the single filaments in the synthetic fiber multifilaments, is an index showing a mixing degree of the single filaments in the cellulose multifilaments and the single filaments in the synthetic fiber multifilaments, and is closely related to a sweat-treating function. That is, a larger A indicates that the single filaments of the synthetic multifilaments and the single filaments of the cellulose multifilaments are more uniformly mixed with each other and that the water absorption rate is more improved. In particular, when A is 50% or more, the water absorption rate is greatly improved, and a sufficient water absorption rate can be obtained without adding a water-absorbing agent in the dyeing step of the fabric.

[0025] Furthermore, since the composite crimped yarn used in the present invention is composed of filaments, friction among filaments is smaller than a spun yarn, and the texture deformation of the knitted or woven fabric is not hindered. Undergarments excellent in stretchability and stretch recovery can therefore be obtained from the fabric of the present invention. Moreover, since the undergarment is prepared from a knitted or woven fabric that is formed from filaments, the undergarment shows good smoothness on the surface and between the undergarment and outerwear that is further worn. As a result, even when the wearer wears garments over the undergarment, the wearer feels neither a stiff feeling nor constrained feeling during wearer's movement, and can obtain a fitted feeling and comfortability.

[0026] Furthermore, as to the material characteristics, cellulose multifilaments are an excellent material because they are less irritating to the skin. In addition to the material characteristics, cellulose multifilaments are still less irritating to the skin due to the shape stability of the filaments and that there are substantially no filament end portions in the knitted fabric which are observed in a spun yarn. However, when a fabric containing 100% of cellulose multifilaments is repeatedly washed, filaments tend to cohere due to the repetition of drying and wetting. As a result, the fabric sometimes becomes stiff to be more irritating to the skin. The cohesiveness of cellulose multifilaments can be suppressed by combination false twisting them and synthetic fiber multifilaments (compositing) in the same manner as in the present invention. Even when the fabric is repeatedly washed, the irritation to the skin can be maintained at a low degree.

[0027] Furthermore, a fabric containing 100% of cellulose multifilaments becomes sticky with a large amount of sweat, and sometimes damages the keratin layer when the wet skin is physically irritated. For the fabric of the present invention, the synthetic fiber multifilaments are separated into respective single filaments by combination false twisting, and the single filaments are each projected out from among the single filaments of the cellulose multifilaments in a gently curved shape (similar to a sine curve) on the surface of the yarn of the composite crimped yarn. As a result, when no pressure is applied to the fabric, the synthetic fiber multifilaments first touch the skin more than the cellulose multifilaments in proportion. However, when the effects of suppressing the stickiness of the fabric during perspiration (spacer effects of the synthetic fiber multifilaments) are comprehensively viewed, irritation to the skin becomes less significant.

[0028] That is, for a fabric containing 100% of cellulose multifilaments, the skin irritation index of the fabric during wetting by perspiration and the like becomes significantly large in comparison with the skin irritation index of the fabric during drying. However, combination false twisting cellulose multifilaments and synthetic fiber multifilaments can make small a difference between the skin irritation index during drying and that during wetting. As a result, undergarments gentle to the skin and less irritating to the skin can be obtained regardless of whether they are dry or wet.

[0029] When such filaments each having a cross-sectional shape excellent in water absorbability (wicking properties brought about by a capillary tube phenomenon) as W-shaped cross-sectional flat yarn, spectacle-shaped flat yarn, π-shaped cross-sectional flat yarn and cross-shaped cross-sectional yarn are used as synthetic fiber multifilaments as described later, the water absorption rate of the fabric is increased, and the diffusibility of sweat in the fabric is enhanced. As a result, the quick drying properties can be improved. That is, a fabric that readily absorbs sweat on the skin and that is excellent in rapid drying can be obtained.

[0030] The fabric of the invention is satisfactory so long as it contains the above knitted or woven fabric, and a fabric at least a portion of which contains the above knitted or woven fabric is included therein.

[0031] In the present invention, the fabric designates a fabric to be worn directly on the skin, and it can be appropriately used for applications such as clothing, bedding, towels or handkerchiefs.

[0032] Examples of the clothing include outerwear, innerwear, pajamas and socks.

[0033] There is no specific limitation on the outerwear so long as one wears it while it is directly contacted with the skin, and it includes clothing that can be seen from outside when one wears it. Examples of the outerwear include T-shirts, polo shirts, cut and sewn, sweaters, sports shirts, work clothing, blouses, shirts, jackets, swimwear, pants and trousers.

[0034] Examples of the innerwear include undergarments, T-shirts, long pants, drawers, spats, trunks, briefs, men's foundation garments having the effects of correcting a form, women's lingerie, foundation garments, shorts, children's undergarments, briefs and shorts. Examples of the women's lingerie include camisoles, slips, petticoats, flare pants, body briefer and teddies. Examples of the women's foundation garments include innerwear having the effects of correcting a form such as brassieres, girdles and body suits.

[0035] Furthermore, the fabric of the present invention is required to be worn directly on the skin over many hours, and to absorb sweat. It is appropriately used as bedding such as sheets, blankets and pillow covers. It can also be appropriately used as towels and handkerchiefs.

Brief Description of the Drawings

[0036] Fig. 1 is a schematic view of an apparatus used for measuring a skin irritation index.

Detailed Description of the Invention

[0037] The knitted or woven fabric used for the fabric of the present invention is obtained by knitting or weaving a composite crimped yarn prepared by combining cellulose multifilaments and synthetic fiber multifilaments at least one-of which is false twisted.

[0038] The mixing ratio of the cellulose multifilaments in the composite crimped yarn used in the present invention is from 15 to 85% by weight, preferably from 20 to 60% by weight, more preferably from 45 to 65% by weight. When the mixing ratio of the cellulose multifilaments is less than 15% by weight, the moisture absorbability necessary for a fabric to be worn directly on the skin becomes insufficient. When the mixing ratio exceeds 85% by weight, the fabric clings to wearer's skin during heavy perspiration to make the wearer unpleasant; moreover, repeatedly washing the fabric tends to produce a change in the feeling.

[0039] The total size of the composite crimped yarn must be from 44 to 333 dtex. A more appropriate range of the total size differs depending on the application. A total size from 167 to 333 dtex is appropriate to an outerwear application. A total size of 167 to 278 dtex is appropriate to a T-shirt application. A total size from 111 to 200 dtex is appropriate to the application of men's undergarments. A total size from 44 to 167 dtex is appropriate to women's undergarments. When the total size of the composite crimped yarn is less than 44 dtex, the fabric to be worn directly on the skin becomes insufficient for a sweat-treating function. When the total size exceeds 333 dtex, the fabric becomes very thick, gives no pleasant feeling, and tends to have an unpleasant touch.

[0040] The single filament size of the cellulose multifilaments is from 0.1 to 5.6 dtex, preferably 2.8 dtex or less, more preferably 1.4 dtex or less. When the single filament size of the cellulose multifilaments exceeds 5.6 dtex, the fabric has an unpleasant touch.

[0041] The single filament size of the synthetic fiber multifilaments is from 0.1 to 5.6 dtex, preferably 2.2 dtex or less, more preferably 1.4 dtex or less. When the single filament size thereof exceeds 5.6 dtex, the fabric has unpleasant hand and skin touches. Moreover, a fabric having a sufficiently small irritation to the skin cannot be obtained. In addition, when the single filament of the cellulose multifilaments and/or the single filament of the synthetic fiber multifilaments has a size of 1.4 dtex or less, it is preferred to use a raw yarn lubricant excellent in openability and false twistability, and to select mild combining conditions in order to prevent the single filaments from cohering during combining. For example, it is preferred to select a weak fluid pressure and a low feed rate as combining conditions. The fluid pressure is preferably from 4.9×10^4 to 2.0×10^5 Pa, and the feed rate is preferably from 0.1 to 2.0%.

[0042] The crimp stretchability of the composite crimped yarn is greater than 4.0% and not greater than 35%, preferably from 8.0 to 25%, more preferably from 10 to 25%. When the crimp stretchability is not greater than 4.0%, the sweat-treating function and stretchability become insufficient. When it exceeds 35%, the fabric comes to have a strong irritation to the skin. When it is 10% or more, a fabric having a particularly excellent sweat-treating function and a sufficient stretchability can be obtained. In particular, when the crimp stretchability is from 10 to 25%, the fabric to be worn directly on the skin has a sufficiently excellent sweat-treating function, a sufficiently excellent stretchability, a good touch and a decreased irritation to the skin. The fabric thus comes to have a significantly balanced function. As a result, the fabric makes the wearer have a greatly comfortable feeling.

[0043] Examples of the cellulose multifilaments used in the present invention include cellulose filaments composed of cuprammonium rayon (cupra), viscose rayon, polynosic rayon, or the like.

[0044] There is no specific limitation on the method of spinning cellulose multifilaments, and any of known methods such as the hank method, cake method, spool method, net process method and continuous method can be employed. Two or more types of the multifilaments may be used in combination. Of these types of multifilaments, cellulose multifilaments obtained by spinning by net processing are preferred due to the following advantages: since cohesion among the single filaments is weak, the cellulose multifilaments can be easily interlaced more uniformly with synthetic fiber multifilaments by fluid interlacing. The single filaments of the cellulose filaments are separate from each other, and do not cohere. As a result, a fabric having a soft touch can preferably be obtained. Moreover, the fabric is preferably prevented from having a hard feeling even when it is washed. Furthermore, since cellulose multifilaments obtained by spinning by net processing show a high filament stretchability, the acceptable conditions of false twist crimping have a wide range, and the twisting tension can be increased. A composite crimped yarn that is more bulky and that has an excellent sweat-treating function can therefore be obtained.

[0045] Moreover, the cellulose multifilaments can be made to contain delustering agents such as titanium oxide and various known additives in accordance with the applications.

[0046] Examples of the synthetic fiber multifilaments include multifilaments composed of polymer such as polyethylene terephthalate, polybutylene terephthalate, polytrimethylene terephthalate, polyester (dyeable under normal pressure), polyamide and polyolefin polyacrylonitrile and copolymer of these polymers.

[0047] There is no specific limitation on the spinning method of these synthetic fiber multifilaments. For example, the multifilaments can be obtained by known methods such as a method in which an undrawn yarn or half drawn yarn obtained by winding at a speed of about 1,500 m/min is used without further processing, a method in which an undrawn yarn or half drawn yarn is stretched and twisted by a factor of about 2 to 3.5, a direct drawing method in which a spinning step and a stretching and twisting step are directly connected and a high speed spinning method in which the winding speed is set at 5,000 m/min or more.

[0048] There is no specific restriction on the cross-sectional shape of a single filament of the synthetic fiber multifilaments yarn. The shape may be polygon-shaped, for example, round-shaped, flat-shaped, triangular, L-shaped, T-shaped, Y-shaped, W-shaped, πshaped, cross-shaped, #-shaped, eight lobe-shaped, octagon-shaped, spectacle-shaped, spectacular two hollow hole-shaped and dog bone-shaped, multi-lobe-shaped, one hollow hole-shaped, plural hollow hole-shaped, and indefinitely shaped; moreover, the cross-sectional shape may also be a mixture of these shapes. Of the cross sections mentioned above, cross sections that are Y-shaped, W-shaped, cross-shaped, #-shaped, spectacle-shaped, spectacular two hollow hole-shaped, L-shaped, or in similar-shapes are preferred because they are excellent in wicking properties due to the capillary phenomenon to show a high absorbability. Moreover, such a filament having a cross-sectional shape with a low bending Young's modulus as a tubular-shaped flat filament, a W-shaped flat filament, a spectacle-shaped flat filament, a spectacular two hollow hole-shaped flat filament and a π-shaped flat filament is preferred because the filament has less frictional irritation to the skin. A W-shaped flat filament, a spectacle-shaped flat filament, a spectacular two hollow hole-shaped flat filament and a π-shaped flat filament are particularly preferred as filaments having both sweat absorbability and less frictional irritation to the skin.

[0049] For the composite crimped yarn, the ratio (A) of S to SG is preferably from 30 to 95%, more preferably from 50 to 95%, wherein S is an area of the duplicating region of the dispersion region of the single filaments in the cellulose multifilaments and the dispersion region of the single filaments in the synthetic fiber multifilaments, and SG is an area of the dispersion region of the single filaments in the synthetic fiber multifilaments. When the ratio is 30% or more, the single filaments of the cellulose multifilaments and the single filaments of the synthetic fiber multifilaments are mixed well, and the water absorption rate is improved to provide comfort. In particular, when the ratio is 50% or more, the fabric very preferably shows an extremely high water absorption rate even without treating the fabric with a water absorbing agent in the dyeing step of the fabric.

[0050] In addition, the dispersion region of single filaments of one type of multifilaments designates a region where the single filaments of the one type of multifilaments are present in dispersion in the cross section of a composite crimped yarn formed by combining different types of multifilaments.

[0051] Next, the method of producing the composite crimped yarn of the invention will be explained. The composite crimped yarn may be produced by any method so long as the yarn thus obtained can achieve the object of the invention. For example, combining and false twisting may be conducted in this order or in the reverse order, and there is no limitation on the production method.

[0052] Examples of the method of combining cellulose multifilament yarn and synthetic fiber multifilament yarn include an air interlacing method called interlacing and a method comprising opening by electric opening with an electrostatic force and interlacing. In the present invention, single filaments of the cellulose multifilaments and single filaments of the synthetic fiber multifilaments must be interlaced at least intermittently. The following are preferred: the single filaments of each of the two types of multifilaments do not cohere alone; both types of single filaments are mixed as uniformly as possible; the single filaments do not stick to and separate from each other; and air is contained among the single filaments.

[0053] In the interlacing method, the number of interlacings per meter of the filament length is preferably 20 or more and 120 or less, more preferably 70 or more and 120 or less from the standpoint of uniform combination. When the number of interlacing is 20 or less, the single filaments are not uniformly combined sometimes. When the number of interlacing exceeds 120, the bulkiness of the yarn decreases, and the sweat-treating function tends to become poor. Moreover, the touch to the skin becomes stiff, and the irritation to the skin tends to increase.

[0054] There is no specific limitation on the method of false twisting that imparts crimping to yarns so long as false twisting can be conducted and the yarns can be heated in the false twisting zone. Commonly used belt nip type false twisting, pin type false twisting, friction type false twisting, air twist type false twisting, and the like can be used.

[0055] False twisting may be conducted prior to combination interlacing. However, in order to conduct combining more uniformly, it is preferred to conduct combination interlacing first and then conduct false twisting. Moreover, when combination interlacing is conducted first and then belt nip type false twisting is conducted, yarns are twisted in the false twisting step so that the cellulose single filaments and the synthetic fiber single filaments are mixed more uniformly.

Accordingly, the procedure is preferred.

[0056] In addition, the use of an apparatus that can continuously conduct combination interlacing and false twisting is preferred because the productivity is improved.

[0057] Furthermore, winding subsequent to texturizing is preferably conducted with a tension of 0.08 cN/dtex or less so that the structure of the composite crimped yarn is not destroyed.

[0058] Two preferred examples will be explained as processes of the production method.

[0059] In the first example, cellulose multifilaments and synthetic fiber multifilaments are combined by air interlacing, and then false twisted. In the example, the preferred ranges of the feed rate and the interlacing pressure differ depending on the type of cellulose multifilament yarn, the type of synthetic fiber multifilament yarn, the specification of the apparatus and the shape of the interlacing nozzle particularly for air interlacing. However, the feed rate in an overfeed region is appropriately from 0.1 to 5%, more appropriately from 0.5 to 2.0%. Moreover, the interlacing pressure is appropriately from 4.9×10^4 to 4.9×10^5 Pa, more appropriately from 9.8×10^4 to 2.0×10^5 Pa.

[0060] When the feed rate exceeds 5%, the texturizing tension varies. As a result, uniform combining is sometimes not conducted. When the feed rate is lower than 0.1% or is an under feed, interlacing becomes insufficient, and the function of the fabric such as water absorbability sometimes falls. When the interlacing pressure exceeds 4.9×10^5 Pa, fluff is formed in the cellulose filaments, and bulkiness is poor to thin the finished yarn. As a result, the sweat-treating function of the fabric sometimes becomes poor. When the interlacing pressure is less than 4.9×10^4 Pa, interlacing becomes insufficient, and the function of the fabric sometimes becomes poor.

[0061] As to the nozzle shape of interlacing, in order to obtain a uniform composite crimped yarn that achieves the object of the present invention, the nozzle preferably has, for example, a shape that blows air in a direction making an angle of 85 degrees or less with the running direction of the yarn.

[0062] The false twisting conditions in the subsequent step will be explained below, although the conditions depend on the melting point of the synthetic fiber multifilaments, and the specification of a heater in the false twisting machine. The heater temperature prior to false twisting is preferably from 100 to 190°C, more preferably from 120 to 190°C, still more preferably from 150 to 180°C. When the heater temperature prior to false twisting is lower than 100°C, sufficient crimping cannot be obtained. When the heater temperature prior to false twisting is as high as exceeding 200°C, the cellulose single filaments are stiffened, and the fabric comes to have a rough touch. As a result, irritation to the skin by the fabric sometimes becomes significant. Moreover, the belt nip system is preferred as the false twisting system because the cellulose multifilaments and the synthetic fiber multifilaments are mutually mixed well to readily give a composite crimped yarn having an excellent function. The false twisting step is conducted at a stretch ratio preferably from 0 to 5% (overfeed region) in order to carry out stabilized production. The stretch ratio is more preferably from 0 to 2% (overfeed region).

[0063] In order to stably obtain the composite crimped yarn that achieves the object of the present invention, the texturizing tension is as explained below. The twisting tension is preferably from 0.16 to 0.27 cN/dtex, and the untwisting tension is preferably from 0.07 to 0.27 cN/dtex. In order to achieve the object of the present invention, the number of twisting is preferably $[(23{,}000/B^{1/2}) + 590] \times 0.80$ (times/m) or more, and $[(23{,}000/B^{1/2}) + 590] \times 0.95$ (times/m) or less, wherein B = (dtex) x 9/10.

[0064] In the preferred second example, the synthetic fiber multifilaments alone are first false twisted, and then the false twisted synthetic fiber multifilaments and cellulose multifilaments are combined. The false twisting conditions of the synthetic fiber multifilaments will be explained below. The heater temperature prior to false twisting is preferably from 100 to 220°C, more preferably from 120 to 190°C, still more preferably from 150 to 190°C, although the heater temperature depends on the melting point of the synthetic fiber multifilaments. When the heater temperature prior to false twisting is lower than 100°C, sufficient crimping is hardly obtained. Moreover, use of a set heater after false twisting is preferred because irritation to the skin is likely to decrease. The set heater temperature is preferably from 100 to 190°C. In order to conduct the stabilized production, the stretch ratio in the false twisting step is preferably from 0.95 to 1.05.

[0065] In order to achieve the object of the present invention, the number of twists is preferably $[(23{,}000/B^{1/2}) + 590] \times 0.70$ (times/m) or more, and $[(23{,}000/B^{1/2}) + 590] \times 1.0$ (times/m) or less, wherein B = (dtex) x 9/10.

[0066] In the subsequent combining step, the false twisted synthetic fiber multifilaments and cellulose multifilaments are combined under the combining conditions as explained below. Preferred ranges of the feed rate and the interlacing pressure differ depending on the type of cellulose multifilament yarn, the type of synthetic fiber multifilament yarn, the specification of the apparatus and, in particular, the shape of the interlacing nozzle for air interlacing. However, the feed rate of the cellulose multifilaments in an overfeed region is appropriately from 0.1 to 5%, more appropriately from 0.5 to 2.0%. Moreover, in order to obtain a fabric excellent in a sweat-treating function, it is preferred to increase the feed rate of the synthetic fiber multifilaments more than that of the cellulose multifilaments by 0.1 to 5%. Moreover, the interlacing pressure is appropriately from 4.9×10^4 to 4.9×10^5 Pa, more appropriately from 9.8×10^4 to 2.0×10^5 Pa.

[0067] When the feed rate of the cellulose fiber multifilaments exceeds 5%, the texturizing tension is not stabilized, and uniform combining is sometimes not conducted. When the feed rate is lower than 0.1% or is an under feed, inter-

lacing becomes insufficient, and the function of the fabric such as water absorbability is sometimes decreased. When the interlacing pressure exceeds 4.9 x 10^5 Pa, fluff is formed in the cellulose multifilaments, and engagement of false twisting becomes poor to thin the finished yarn. As a result, the sweat-treating function of the fabric is sometimes worsened. When the interlacing pressure is less than 4.9 x 10^4 Pa, interlacing becomes insufficient, and the function of the fabric is sometimes worsened.

[0068] The wet frictional coefficient, that is an index showing stickiness to the skin of the knitted or woven fabric used in the present invention, is preferably 3.0 or less, more preferably 2.0 or less. When the wet frictional coefficient of the knitted or woven fabric exceeds 3.0, the wearer's sticky feeling and wet feeling become significant during the wearer's perspiration, and the wearer's comfortable feeling sometimes worsens. Moreover, when the wet frictional coefficient is 2.0 or less, the wearer's sticky feeling and wet feeling become still more insignificant, and the fabric makes its wearer feel very comfortable.

[0069] Furthermore, for the knitted or woven fabric used in the present invention, SB that is defined by the formula (2) and that is a measure of a cool and refreshing feeling in a sweaty environment preferably satisfies the formula (1), and SN that is defined by the formula (4) and that is a measure of a cool and refreshing feeling in a perspiratory environment thereof preferably satisfies the formula (3):

$$0.0 < SB < 100.0 \quad (1)$$

$$SB = 1.08 \times (\text{heat dissipation amount}) + 1.98 \times (\text{surface unevenness}) + 6.25 \times (\text{surface frictional coefficient}) - 13.92 \quad (2)$$

$$0.0 < SN < 100.0 \quad (3)$$

$$SN = -0.03 \times (\text{water transport amount}) + 1.42 \times (\text{moisture transfer degree}) + 0.17 \times (\text{heat dissipation amount}) + 0.76 \times (\text{surface unevenness}) + 12.1 \times (\text{surface frictional coefficient}) - 16.6 \quad (4)$$

[0070] That is, when SB that is a measure of a cool and refreshing feeling in a sweaty environment and SN that is a measure of a cool and refreshing feeling in a perspiration inducing environment are each greater than zero and less than 100, a wearer of the fabric has a cool and refreshing feeling and feels comfortable in a sweaty or perspiration inducing environment. When the product of SB and SN is 0.5 or more, the wearer has a significant cool and refreshing feeling.

[0071] SB and SN mentioned above are derived from the following tests as a measure of a cool and refreshing feeling by the present inventors.

[0072] That is, many fabrics that are different from each other in the type of the fiber, structure of the fiber, combination of fibers, type of the knitted or woven fabric, structure of the knitted or woven fabric or the like were prepared, and sewed to give innerwear. Wearing tests were conducted, and factor abstraction of a cool and refreshing feeling was conducted. Specifically, many test wearers were selected, and trial garments were distributed to them while details were concealed. They were each asked to repeatedly wear one garment per day over a long period of time in their daily life, and they evaluated 18 factors related to a cool and refreshing feeling each time they wear. As a result, the following have become evident. Three major criteria of the judgment of a cool and refreshing feeling in a sweaty environment are as follows: the garment is not sticky with sweat; the garment has not sweaty, sticky feeling; and the garment has a nonsticky touch. However, the following have become the criteria of judgment of a garment in a perspiratory environment: the garment does not become sticky with sweat; the garment clings to the skin; the garment has not sweaty, sticky feeling; and heat dissipates. That is, the criterion that the garment has a nonsticky touch, as mentioned above evidently becomes less important.

[0073] Next, the physical properties of the knitted or woven fabrics having been subjected to wearing tests have

been tested. That is, forty-three physical property items having been determined from various viewpoints and including the following physical properties were measured: physical properties related to water, physical properties humidity, physical properties related to heat, physical properties related to surface shapes, physical properties related to feelings and fabric deformation degrees. The relationships between the measured results and the above sensory test results were analyzed, and the importance of the physical property items of fabrics contributing to a cool and refreshing feeling was determined. As a result, SB and SN have been defined by the formulas (2) and (4), respectively as a measure of a cool and refreshing feeling.

[0074] The heat dissipation amount ($W/m^2 \cdot °C$) in the above formulas (2) and (4) designates the ability to release heat within a garment, and its preferred range is from 10 to 15 $W/m^2 \cdot °C$. The surface unevenness designates an unevenness of the fabric on the side contacted with the skin, and its preferred range is from 0.2 to 1.5. The surface frictional coefficient designates an unsmoothness of the fabric on the side contacted with the skin, and its preferred range is from 0.20 to 0.35. The water transport amount (%) expresses how it is difficult for the sweat absorbed to the fabric to return to the skin. Its preferred range is from 0 to 50%. The moisture transfer degree designates the ability of the fabric to release moisture within the garment. Its preferred range is from 10.0 to 11.0. These values can be measured by methods to be described later.

[0075] Furthermore, in the present invention, the skin irritation index of the above knitted fabric or the like is preferably 8.0 μS or less. When the skin irritation index exceeds 8.0 μS, the physical frictional irritation to the skin keratin layer becomes significant. As a result, a wearer having a sensitive skin sometimes feels itchy depending on the season, and the skin sometimes becomes red.

[0076] The skin irritation index is an index that shows the degree of frictional irritation produced when the fabric in use is in contact with the skin, and can be measured by the evaluation method proposed by the present inventors. The evaluation method utilizes a phenomenon that peeling of keratin caused by frictional physical irritation makes the inner layer portion of the keratin appear on the skin surface to increase the keratin moisture. In the method, a weak high frequency current (a frequency of about 3.5 MHz) is applied to the skin, and a change in the amount of the keratin moisture is measured as an electric admittance (siemens [S]). In addition, the details of the measuring method will be described later.

[0077] Furthermore, when the fabric is formed from a knitted fabric, the knitted fabric is preferred to have physical properties as described below from the standpoint of obtaining a fabric that is excellent in stretchability and stretch recovery, and that gives the wearer no restrained feeling during wearer's movement so that the wearer can easily move and has a fitted feeling. The knitted fabric shows a stretch stress of preferably 20 cN/cm width or less when stretched by 50% in the warp direction thereof, more preferably 15 cN/cm width or less. Moreover, the knitted fabric shows a stretch stress of preferably 20 cN/cm width or less when stretched by 80% in the weft direction thereof, more preferably from 1 to 15 cN/cm width. Moreover, the knitted fabric shows a stretch recovery ratio of preferably 80% or more when stretched by 50% in the warp direction, more preferably from 85 to 100%. Furthermore, the knitted fabric shows a stretch recovery ratio of preferably 80% or more when stretched by 100% in the weft direction, more preferably from 85 to 100%.

[0078] The knitted fabric of the present invention has a mass per unit area preferably from 80 to 250 g/m^2, more preferably from 80 to 180 g/m^2. When the knitted fabric has a mass per unit area of less than 80 g/m^2, the sweat-treating function sometimes becomes insufficient. When it exceeds 250 g/m^2, the knitted fabric becomes excessively heavy, and the wearer sometimes feels uncomfortable.

[0079] Furthermore, there is no specific limitation on the method of producing a knitted or woven fabric from a composite crimped yarn in the present invention. It can be produced with a conventional knitting or weaving machine. Moreover, it may also be produced by knitting or weaving in the manner of mixing with other materials such as spandex, synthetic fiber, cotton and silk.

[0080] Examples of the texture of the knitted fabric include various textures of tubular knitting and weft knitting such as circular rib, interlock, plain knitting, tuck float, KATABUKURO (a kind of textures), Ponte di Roma, Mirano rib and pearl knitting, tricot textures such as half tricot, two way, double denvy and atlas, raschel textures such as satin net and trico net, and a weft yarn inlay texture. Moreover, modified textures of these textures may also be used. A suitable texture can be selected in accordance with the application. The knitted texture preferably has a relatively low thread count, and is rich in elastic properties.

[0081] For example, for an interlock texture, the loop length L (cm) of stitches forming the knitted fabric and the total size D (dtex) of the composite crimped yarn satisfy preferably the formula (5), more preferably the formula (6):

$$2.9\ (cm) \leqq (L/D^{1/2}) \times 100 \qquad (5)$$

$$3.8\ (cm) \leqq (L/D^{1/2}) \times 100 \quad (6)$$

[0082] For a circular rib texture, the loop length L (cm) of stitches forming the knitted fabric and the total size D (dtex) of the composite crimped yarn satisfy the formula (7), more preferably the formula (8):

$$2.1\ (cm) \leqq (L/D^{1/2}) \times 100 \quad (7)$$

$$3.1\ (cm) \leqq (L/D^{1/2}) \times 100 \quad (8)$$

[0083] For a plain knitting texture, the loop length L (cm) of stitches forming the knitted fabric and the total size D (dtex) of the composite crimped yarn preferably satisfy the formula (9):

$$2.1\ (cm) \leqq (L/D^{1/2}) \times 100 \quad (9)$$

[0084] When the above textures do not satisfy the formulas (5), (7) and (9), respectively, the fabrics sometimes show an insufficient sweat-treating function and heat retaining properties.

[0085] Furthermore, examples of the texture of a woven fabric include a plain weave, a twill weave, a satin weave and their modified textures.

[0086] There is no specific restriction on the method of treating a knitted or woven fabric used for the fabric of the present invention. The knitted or woven fabric may be made white by bleaching and bleach finishing, and it may also be dyed. For example, any of the dyeing methods such as yarn dyeing conducted in the state of a yarn such as hank or cheese, namely in the state of a composite crimped yarn, and piece dyeing conducted in the state of a knitted or woven fabric may be carried out. Dyes, dyeing assistants and finishing agents used for dyeing generally marketed synthetic fibers and/or cellulose fibers can optionally be selected in accordance with the applications. Moreover, fluorescent brighteners may also be optionally used. Furthermore, when a knitted or woven fabric is to be dyed, such pretreatments that are ordinarily practiced prior to dyeing as mentioned below may be conducted: scouring; bleaching; alkali treating for improving the dye-affinity of cellulose fibers; and alkali reduction of polyester fibers.

[0087] Furthermore, it is preferred to conduct finish setting to such a degree that wrinkles are smoothed out, for the purpose of obtaining a fabric showing a soft feeling and a decreased irritation to the skin, and having an excellent sweat-treating function. When the effects of finish set are too strong, crimping of the composite crimped yarn in the fabric is sometimes impaired to decrease the sweat-treating function and lower the stretchability of the fabric. Moreover, when the set temperature is too high, the cellulose multifilaments in the fabric are stiffen, and the fabric sometimes has a stiff feeling and gives a irritation to the skin. Concretely, when wet heat set is conducted at 180°C for 1 minute or more, the fabric sometimes comes to have a stiff feeling. When dry heat set is conducted at 190°C for 1 minute or more, the fabric sometimes comes to have a stiff feeling.

Examples

[0088] The present invention will be more specifically explained below by making reference to examples. In addition, evaluation values in the examples were measured by the following methods.

(1) Wet Frictional Coefficient

[0089] A friction tester (trade name of KES-FE, manufactured by Kato Tekku K.K., hereinafter called a friction sensitivity tester) is used.

[0090] An acrylic plate (dimensions of 8 x 12 cm, a thickness of 5 mm) is placed on the sample stand of a friction sensitivity tester, and fixed with a tape, etc. The mass of a sample (5 cm long in the warp direction and 3 cm long in the weft direction of the knitted or woven fabric) is measured.

[0091] A yarn of 25 cm long (T span No. 60, manufactured by Shikibo Ltd.) is sewed on the entire end portion 1 mm apart from the end portion on one short side of the sample while attention is being paid so that the sample is situated in the central portion of the yarn.

[0092] Moisture (0.4 ml of water) is substantially uniformly sprayed on the sample with a simplified sprayer for ironing. The sample is allowed to stand for 1 minute to uniformly contain the moisture over the entire sample. The moving

direction of the friction sensitivity tester is made to agree with the long side direction (warp direction of the knitted or woven fabric) of the wetted sample so that the short side on which the yarn has been sewed is on the sensor side, and the sample is placed on an acrylic plate.

[0093] Both ends of the sewed portion of the yarn having been sewed on the sample are suspended on the sensor hanging axis of the friction sensitivity tester; the height of the sensor hanging axis is adjusted to make the yarn horizontal. Moreover, the digital panel of the friction sensitivity tester is confirmed to display a numerical value of 0.00, that is, it is confirmed that no force is applied to the sample. A start button is then pushed, and a frictional coefficient MIU is read.

[0094] Five samples are prepared from five respective sites of each fabric, and MIU is measured. The average value of MIU at five sites is defined as the wet frictional coefficient of the fabric.

(2) Heat Dissipation Amount

[0095] A Thermo Labo II (trade name, manufactured by Kato Tekku K.K.) is used. A 15 cm x 15 cm sample is placed on the hot plate (entire hot plate having dimensions of 12 cm x 12 cm, a hot plate for measurement having dimensions of 10 cm x 10 cm with a guard hot plate 1 cm wide placed around the periphery) so that the back surface (surface to be contacted with the skin, for example, a surface to be on the body side when the fabric is used as an undergarment) of the sample is contacted with the hot plate. A foamed polystyrene frame (15 cm x 15 cm, having a 10 cm x 10 cm hole in the central portion, having a thickness of 3 mm) is further placed on the sample, and fixed from the upper side with a drafting tape (manufactured by Nichiban Co., Ltd.).

[0096] When the wind speed is 0.2 m/sec (for the measuring apparatus, a proper scale for making the wind speed 0.2m/sec is read from a wind speed scale and a wind speed calibration curve, and the scale is set therefor), a heat amount ($W/m^2 \cdot °C$) necessary for holding the hot plate at 30°C is measured.

(3) Surface Unevenness

[0097] Using a KES (trade name, manufactured by Kato Tekku K.K.), the surface unevenness (SMD) of the back surface (surface to be contacted with the skin, for example, the surface to be on the body side of the fabric when used as an undergarment) is measured in the warp and the weft direction under the following conditions: the load applied to the sample of 200 g; a piano wire 0.5 mm in diameter and 5 mm long used as a contact probe; a contact force of the contact probe of 9.8 cN; a moving speed of 1 mm/sec; and a 20 cm x 20 cm sample.

[0098] Of the surface unevenness values thus obtained, a larger value (in the warp or weft direction) is taken into consideration. The larger value is divided by the number of protrusions that are present in a measured distance of 2 cm and that are read from the measurement chart to give the surface unevenness.

(4) Surface Frictional Coefficient

[0099] Using a KES (trade name, manufactured by Kato Tekku K.K.), the surface frictional coefficient (MIU) of the back surface (surface to be contacted with the skin, for example, the surface to be on the body side of the fabric when used as an undergarment) is measured in the warp and the weft direction under the following conditions: the load applied to the sample of 200 g; piano wires (5 x 5 mm arranged in parallel) each 0.5 mm in diameter and 5 mm long used as a contact probe; a contact force of the contact probe of 49 cN; a moving speed of 1 mm/sec; and a 20 cm x 20 cm sample. The average value is used as a desired frictional coefficient.

(5) Water transport Amount

[0100] A 7 cm x 7 cm sample is placed on a 10 cm x 10 cm glass plate so that the back surface (surface to be contacted with the skin, for example, the surface to be on the body side of the fabric when used as an undergarment) faces the upper side. Water in an amount of 0.8 ml is quietly dropped on the sample from a site about 5 mm above the sample. The sample is allowed to stand for 10 minutes. A 10 cm x 10 cm filter paper having been weighed, a 10 cm x 10 cm glass plate and a weight (500 g) are successively placed on the sample, and allowed to stand for 10 sec. The mass increment of the filter is then found, and the desired value is obtained from the formula:

$$\text{Water transport amount}(\%) = [\text{mass increment of the filter paper (g)}/0.8\ (g)] \times 100$$

(6) Moisture Transfer Degree

[0101] A Thermo Labo II (trade name, manufactured by Kato Tekku K.K.) is used. A plastic sheet (trade name of

Saran Wrap, manufactured by Asahi Chemical Industry Co., Ltd.) accurately cut to have dimensions of 20 cm x 20 cm is applied to the hot plate (entire hot plate having dimensions of 12 cm x 12 cm, a hot plate for measurement having dimensions of 10 cm x 10 cm with a guard hot plate 1 cm wide placed around the periphery and having a temperature of 32.2°C) at 32.0°C in an environment at 22°C at 65% RH so that air is not left between the sheet and the hot plate. An acrylic resin frame (15 cm x 15 cm, having a 10 cm x 10 cm hole in the central portion, having a thickness of 5 mm, polyester monofilament yarns being strung across the central hole at intervals of 15 mm in the longitudinal direction and in the transverse direction in a lattice-like form) is placed on the hot plate. A 15 cm x 15 cm sample is further placed on the resin frame with the back surface (surface to be contacted with the skin, for example, surface to face the body side when an undergarment is prepared therefrom) facing the hot plate side. An acrylic resin frame (15 cm x 15 cm, having a 10 cm x 10 cm hole in the central portion, having a thickness of 5 mm) is further placed on the sample. The plastic sheet is folded back around the periphery of the acrylic frame. The resultant system is allowed to stand for 20 minutes, and a heat quantity W I (W) necessary for holding the hot plate at 32.0°C is measured.

[0102] Next, a 20 cm x 20 cm plastic sheet (trade name of Saran Wrap, manufactured by Asahi Chemical Industry Co., Ltd.) is applied to a hot plate (entire hot plate having dimensions of 12 cm x 12 cm, a hot plate for measurement having dimensions of 10 cm x 10 cm with a guard hot plate 1 cm wide placed around the periphery and having a temperature of 32.2°C) at 32.0°C so that air is not left between the sheet and the hot plate. A 9 cm x 9 cm filter paper is placed on the central portion of the hot plate, and the whole filter paper is impregnated with 0.3 ml of water. An acrylic resin frame (15 cm x 15 cm, having a 10 cm x 10 cm hole in the central portion, having a thickness of 5 mm, polyester monofilament yarns being strung across the central hole at intervals of 15 mm in the longitudinal direction and in the transverse direction in a lattice-like form) is placed on the hot plate. A 15 cm x 15 cm sample is placed on the resin frame with the back surface (surface to be contacted with the skin, for example, surface to face the body side when an undergarment is prepared therefrom) facing the hot plate. An acrylic resin frame (15 cm x 15 cm, having a 10 cm x 10 cm hole in the central portion, having a thickness of 5 mm) is further placed on the sample. The plastic sheet is folded back around the periphery of the acrylic frame. The resultant system is allowed to stand for 20 minutes, and a heat quantity W II (W) necessary for holding the hot plate at 32.0°C is measured. The desired moisture transfer degree is defined by the formula:

$$[(W\,II - W\,I)/6.08] \times 46.944 - 1.022$$

(7) Stretch Stress

①W arp Direction:

[0103] Three samples each having dimensions of 16 cm (warp) x 2.5 cm (weft) are taken from a knitted fabric. Using a constant-speed stretch tensile testing machine, a grip-to-grip interval of a sample is set at 10 cm under an initial load of 1 g, and the sample is stretched by 50% (until the grip-to-grip interval becomes 15 cm) at a speed of 30 cm ± 2 cm/min. The tension F1 (cN) at the time of stretching by 50% is read from the stretch-load curve, and F1 (cN)/2.5 (cm width) is defined as a stretch stress (cN/cm width) in the warp direction at the time of stretching by 50%. Measurements are made three times, and the average value is employed.

②Wef t Direction:

[0104] Three samples each having dimensions of 16 cm (weft) x 2.5 cm (warp) are taken from a knitted fabric. Using a constant-speed stretch tensile testing machine, a grip-to-grip interval of a sample is set at 10 cm under an initial load of 1 g, and the sample is stretched by 80% (until the grip-to-grip interval becomes 18 cm) at a speed of 30 cm ± 2 cm/min. The tension F2 (cN) at the time of stretching by 80% is read from the stretch-load curve, and F2 (cN)/2.5 (cm width) is defined as a stretch stress (cN/cm width) in the weft direction at the time of stretching by 80%. Measurements are made three times, and the average value is employed.

(8) Stretch Recovery Ratio

①W arp Direction:

[0105] Three samples each having dimensions of 16 cm (warp) x 2.5 cm (weft) are taken from a knitted fabric. Using a constant-speed stretch tensile testing machine, a grip-to-grip interval of a sample is set at 10 cm (S0) under an initial load of 1 g/2.5 cm width, and the sample is stretched by 50% (until the grip-to-grip interval becomes 15 cm), the grip-to-grip interval being defined as S1, at a speed of 30 cm ± 2 cm/min. The sample is then immediately returned to the

initial position at the same speed without allowing it to stand. The sample is then stretched again at the same speed after 30 sec so that a stretch-load curve is depicted, and a grip-to-grip interval (S2) under a load of 1 g (same as the initial load) is read.

[0106] The stretch recovery ratio is calculated from the following formula (9):

$$[(S1 - S2)/(S1 - S0)] \times 100\ (\%) \qquad 59°$$

Measurements are made three times, and the average value is employed.

②Wef t Direction:

[0107] Three samples each having dimensions of 16 cm (weft) x 2.5 cm (warp) are taken from a knitted fabric. Using a constant-speed stretch tensile testing machine, a grip-to-grip interval of a sample is set at 10 cm (S0) under an initial load of 1 g/2.5 cm width, and the sample is stretched by 100%.(until the grip-to-grip interval becomes 20 cm), the grip-to-grip interval being defined as S1, at a speed of 30 cm ± 2 cm/min. The sample is then immediately returned to the initial position at the same speed without allowing it to stand. The sample is then stretched again at the same speed after 30 sec so that a stretch-load curve is depicted, and a grip-to-grip interval (S2) under a load of 1 g (same as the initial load) is read.

[0108] The stretch recovery ratio is calculated from the following formula (10):

$$[(S1 - S2)/(S1 - S0)] \times 100\ (\%) \qquad (10)$$

Measurements on the sample are made three times, and the average value is employed.

(9) Skin Irritation Index During Drying

①F riction Testing Machine:

[0109] A skin friction testing apparatus manufactured by Asahi Chemical Industry Co., Ltd. is used. As shown in Fig. 1, the apparatus has a friction probe (contact pressure probe) 1 to the bottom portion of which a sample is attached, a load cell 2 that measures a load of the friction probe in the friction direction, an arm 6, a weight 3 (the length of the arm 6 and the weight of the weight 3 controlling the contact pressure), a motor 4 that controls the horizontal movement (amplitude, speed) of the friction probe and an armrest 5 that is detachable. A body portion that has the skin to be measured is placed on the armrest 5, and the friction probe 1 is contacted with the portion, followed by rubbing the portion. In addition, reference numerals 7, 8 in Fig. 1 designate a column and a base, respectively.

②K eratin Moisture-Measuring Apparatus:

[0110] SKICON-200 (measuring by impedance method, manufactured by I. B. S. K.K.)

③P anelists:

[0111] Five men and five women (Japanese each living in an area not located in a mountainous cold district of from 133 to 138 degrees of east longitude and from 34 to 35.2 degrees of north latitude for 3 years or more) aged between twenty and forty and each having a healthy skin.

④T ime of Year for Making Measurements:

[0112] April

⑤P retreatment of Samples:

[0113] Samples are humidified in an environment at 20°C at 60% RH.

⑥S kin Portion to Be Measured:

[0114] The inner side of the antebrachium excluding the area 5 cm or less apart from the wrist joint and the area 5 cm or less apart from the elbow joint, and also excluding a portion where a vulnus exists

[0115] When measurements of a plurality samples are to be made on the same subject, it is necessary to avoid the skin portion of the antebrachium where the measurement has been made so that measurements are not made on the same skin portion twice or more. The skin portion where the measurement has once been made cannot be used for one month.

⑦P retreatment of the Skin:

[0116] Prior to rubbing the skin, absorbent wadding impregnated with an aqueous solution containing 0.25% of sodium laurylsulfate (0.5 ml/g) is placed on a portion of the skin to be rubbed, and sealed with a nonpermeable adhesive tape for 12 hours. The skin portion is subsequently washed with water, and the subject sits quietly for 30 minutes in an environment at 20°C at 60% RH while the skin portion to be rubbed is being exposed to the air. The antebrachium is then placed on the horizontal armrest, and the keratin moisture amount of the skin portion to be rubbed is measured.

⑧M ethod of Measuring Keratin Moisture:

[0117] Measurements are made at 10 sites in one skin portion to be rubbed, and the average value is determined (unit: μS)

⑨R ubbing Treatment:

[0118] A sample of knitted or woven fabric is attached to the contact probe having a rubbing area of 3 cm^2 (1.5 cm x 2 cm) in the same environment. The skin portion to be rubbed of the antebrachium placed on the armrest is confirmed to be in parallel with the contact pressure probe, and the portion is rubbed under the following conditions:

contact pressure: 980 Pa;
rubbing speed: 60 times/min (round-trip motion); and
number of rubs: 500 times (round-trip motion).

[0119] The subject quietly sits for 20 minutes after rubbing, in the same environment, and the keratin moisture amount of the rubbed skin portion is measured again.

[0120] The difference (unit: μS) between the keratin moisture amount prior to rubbing and the one subsequent to rubbing is calculated. Measurements are made in the same manner on 10 subjects, and the average value of the difference between the keratin moisture amount prior to rubbing and the one subsequent to rubbing is defined as the skin irritation index during drying.

(10) Skin Irritation Index during Wetting

[0121] The following are the same as in the method of (9) explained above: ① a friction testing machine, ② a keratin moisture-measuring apparatus, ③ panelists and ④ time of year for making measurements.

⑤P retreatment of a Sample:

[0122] Moisture in an amount of 100% based on the mass of a sample humidified for 24 hours or more in an environment at 20°C at 60% RH is substantially uniformly applied to the sample with a sprayer, and the sample is allowed to stand for 1 minute.

⑥S kin Portion to Be Measured:

[0123] The inner side of the antebrachium excluding the area 5 cm or less apart from the wrist joint and the area 5 cm or less apart from the elbow joint, and also excluding a portion where a vulnus exists.

[0124] When measurements of the index of a plurality samples are to be made using the same subject, it is necessary to avoid the skin portion of the antebrachium where the measurement has been made so that measurements are not made on the same skin portion twice or more. It is also necessary not to use the same skin portion where the skin irritation index during drying of the same type of sample has been measured. A rubbed skin portion where the meas-

urement has once been made cannot be used for one month.

[0125] The following are carried out in the same manner as in (9) explained above: ⑦ pretreatment of the skin; and ⑧method of measuring keratin moisture.

⑨Rubbing Treatment:

[0126] A sample knitted or woven fabric is attached to the contact pressure probe having a rubbing area of 3 cm^2 (1.5 cm x 2 cm) in the same environment. The skin portion to be rubbed of the antebrachium placed on the armrest is confirmed to be in parallel with the contact pressure probe, and the portion is rubbed under the following conditions:

contact pressure: 980 Pa;
rubbing speed: 60 times/min (round-trip motion); and
number of rubs: 500 times (round-trip motion).

[0127] The subject quietly sits for 20 minutes after rubbing, in the same environment, and the keratin moisture amount of the rubbed skin portion is measured again.

[0128] The difference (unit: μS) between the keratin moisture amount prior to rubbing and the one subsequent to rubbing is calculated. Measurements are made in the same manner on 10 subjects, and the average value of the difference between the keratin moisture amount prior to rubbing and the one subsequent to rubbing is defined as the skin irritation index during wetting.

(11) Crimp Stretch Ratio

[0129] The crimp stretch ratio is measured by the following method, and is obtained by averaging 10 measured values using the formula (11) shown below.

[0130] A composite crimped yarn having a total size of D (dtex) is rewound 1/(0.0003 x D x 9/10) times at a speed of 120 times/min using a counter wheel having a frame periphery of 1 m. A load of 2 g is suspended from the hank thus obtained and hung down, and the hank is treated at 90°C for 15 minutes.

[0131] Yarn samples each about 30 cm long are taken from various sites of the hank thus treated so that the crimp is not stretched as much as possible. First, an initial load of 1.8 (mg/dtex) x D (detx) x D (dtex) is suspended from a sample, and hung down. The sample is marked at an interval of 20 cm after 30 sec. The mark-to-mark length is defined as K0 (cm). The initial load is removed, and then a load of 90 (mg/dtex) x D (dtex) is suspended from the sample, and hung down. The mark-to-mark length K (cm) is read after 30 sec.

$$[(K - K0)/K0] \times 100\ (\%) \qquad (11)$$

(12) Loop Length

[0132] Stitches of 100 wales in the same course of a knitted fabric are marked. Next, the composite crimped yarn is loosened with a force as small as possible from the end direction of the marked knitted fabric. An initial load of 90 (mg/dtex) x D (dtex) is suspended and hung down. The mark-to-mark length Lw (cm) is read after 30 sec. The loop length L (cm) is defined as Lw/100.

(13) Dispersion Region of Single Filaments

①Preparation of a Cross-Sectional Section Photograph:

[0133] A load of 0.9/50 (g/dtex) is applied to a composite crimped yarn, and optional three portions of the yarn in the longitudinal direction are embedded in resin while the stretched state is being maintained. When the resin is cured, thin slices (cross-sectional sections) are prepared by sectioning with a microtome. Each of the cross-sectional sections is photographed (x 500).

②Area SC of the Dispersion Region of Single Filaments of Cellulose Multifilaments:

[0134] In the photograph of a cross-sectional section, a polygon surrounding the single filaments of cellulose multifilaments is prepared by the following procedure: lines each circumscribing the cross sections of any two adjacent single filaments of the cellulose multifilaments are successively drawn in such a manner that none of the single filaments

thereof exist outside the drawn lines. The area SC of the polygon is obtained by image analysis software (trade name of IP-1000, manufactured by Asahi Chemical Industry Co., Ltd.).

③A rea SG of the Dispersion Region of Single Filaments of Synthetic Fiber Multifilaments:

[0135] In the photograph of a cross-sectional section, a polygon surrounding the single filaments of synthetic fiber multifilaments is prepared by the following procedure: lines each circumscribing the cross sections of any two adjacent single filaments of the synthetic fiber multifilaments are successively drawn in such a manner that none of the single filaments thereof exist outside the drawn lines. The area SG of the polygon is obtained by the image analysis software (trade name of IP-1000, manufactured by Asahi Chemical Industry Co., Ltd.).

④ Duplicating Area S of the Dispersion Region of the Single filaments in Cellulose Multifilaments and the Dispersion Region of Single Filaments in Synthetic Fiber Multifilaments:

[0136] The area S of the duplicating region of the polygon (prepared in ②) surrounding the single filaments of the cellulose multifilaments and the polygon (prepared in ③) surrounding the single filaments of the synthetic fiber multifilaments is obtained by the image analysis software (trade name of IP-1000, manufactured by Asahi Chemical Industry Co., Ltd.)

⑤T he ratio of S to SG is calculated from the formula:

[0137]

$$a(\%) = (S/SG) \times 100$$

⑥F or each of the cross-sectional sections prepared from the optional three portions in the longitudinal direction of the composite crimped yarn, a is determined.

[0138] The average value of a is defined as A of the composite crimped yarn.

Example 1

[0139] A cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 45 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co. Ltd.) with 83 dtex 30 filaments that was used as synthetic fiber multifilaments were fed to a friction false twisting machine (trade name of 33H Mach Climper, manufactured by Murata Machinery Ltd.) of a belt nip type, and both filamentary yarns were interlaced under the following conditions, and continuously false twisted.

①I nterlacing

[0140]

Interlacing nozzle: 1.5 mm in diameter, driving type (trade name of KC-AJI-L, manufactured by Kyocera Corporation)
Feed rate: both filamentary yarns being overfed by 1.5%
Air pressure: 1.5 x 10^5 Pa, texturizing speed: 300 m/min

②F alse Twisting

[0141]

False twisting heater: 175°C, set heater: not used
Twister belt cross angle: 100 degrees, twister belt contact pressure: 275 cN
Number of false twisting: 2151 t/m, stretch ratio: 1.000
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex

Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min
Using the composite crimped yarn thus obtained having a total size of 167 dtex, a circular rib texture was knitted with a 20-gauge double tubular knitting machine (number of needles: 1,360 for each bed) 53.3 cm (21 inches) in diameter. The knitted loop length was 0.53 cm/wales.

[0142] The knitted fabric was bleached with a scouring agent and hydrogen peroxide at temperature from 80 to 90°C for 30 minutes, using a jet dyeing machine. The pH was adjusted, and the knitted fabric was washed with water, and boiled at 100°C for 20 minutes. The knitted fabric was then washed with water, dried with a suction drum, and steam set at 170°C for 1 minute to give a fabric in Example 1.

Example 2

[0143] A fabric in Example 2 was obtained by repeating the procedure of Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 44 dtex 24 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co., Ltd.) with 167 dtex 60 filaments that was used as synthetic fiber multifilaments were fed and that the following conditions were employed.

①I nterlacing

[0144] Interlacing was conducted in the same manner as in Example 1.

②F alse Twisting

[0145]

False twisting heater: 175°C, set heater: not used
Twister belt cross angle: 115 degrees, twister belt contact pressure: 275 cN
Number of false twisting: 2,122 t/m, stretch ratio: 1.003
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex
Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min
Using the thus obtained composite crimped yarn having a total size of 211 dtex, a circular rib texture was knitted with an 18-gauge double tubular knitting machine. The knitted loop length was 0.59 cm/wale.

Example 3

[0146] A fabric in Example 3 was obtained by repeating the procedure of Example 2 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 133 dtex 70 filaments that was used as cellulose multifilaments and round-shaped cross-sectional polyester (manufactured by Asahi Chemical Industry Co., Ltd.) with 56 dtex 24 filaments that was used as synthetic fiber multifilaments were fed and that the following conditions were employed.

①I nterlacing

[0147] Interlacing was conducted in the same manner as in Example 1.

②F alse Twisting

[0148]

False twisting heater: 170°C, set heater: not used
Twister belt cross angle: 110 degrees, twister belt contact pressure: 275 cN
Number of false twisting: 2170 t/m, stretch ratio: 0.985
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex
Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min
Using the thus obtained composite crimped yarn having a total size of 211 dtex, a circular rib texture was knitted

with an 18-gauge double tubular knitting machine. The knitted loop length was 0.56 cm/wale.

Example 4

[0149] A fabric in Example 4 was obtained by repeating the procedure of Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 18 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 30 filaments that was used as synthetic fiber multifilaments were fed.

Example 5

[0150] A fabric in Example 5 was obtained by repeating the procedure of Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 74 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 30 filaments that was used as synthetic fiber multifilaments were fed and that the interlacing feed rate was set at 0.9%.

Example 6

[0151] A fabric in Example 1 was obtained by repeating the procedure of Example 6 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 45 filaments that was used as cellulose multifilaments and round-shaped cross-sectional polyester (manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 24 filaments that was used as synthetic fiber multifilaments were fed.

Example 7

[0152] A fabric in Example 7 was obtained by repeating the procedure of Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 45 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 60 filaments that was used as synthetic fiber multifilaments were fed.

Example 8

[0153] A fabric in Example 8 was obtained by repeating the procedure of Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 45 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 30 filaments that was used as synthetic fiber multifilaments were fed and that the following conditions were employed.

①I nterlacing

[0154] Interlacing was conducted in the same manner as in Example 1.

②F alse Twisting

[0155]

False twisting heater: 170°C, set heater: not used
Twister belt cross angle: 92.5 degrees, twister belt contact pressure: 275 cN
Number of false twisting: 2032 t/m, stretch ratio: 1.000
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex
Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min

Example 9

[0156] A fabric in Example 9 was obtained by repeating the procedure of Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 45 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (Trade Name of Technofine manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 30 filaments that was used as synthetic fiber multifilaments were fed and that the following conditions were employed.

①I nterlacing

[0157] Interlacing was conducted in the same manner as in Example 1.

②F alse Twisting

[0158]

False twisting heater: 170°C, set heater: not used
Twister belt cross angle: 95 degrees, twister belt contact pressure: 275 cN
Number of false twisting: 2071 t/m, stretch ratio: 1.000
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex
Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min

Example 10

[0159] A fabric in Example 10 was obtained by repeating the procedure of Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 45 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (Trade Name of Technofine manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 30 filaments that was used as synthetic fiber multifilaments were fed and that the following conditions were employed.

①I nterlacing

[0160] Interlacing was conducted in the same manner as in Example 1.

②F alse Twisting

[0161]

False twisting heater: 170°C, set heater: not used
Twister belt cross angle: 97.5 degrees, twister belt contact pressure: 275 cN
Number of false twisting: 2111 t/m, stretch ratio: 1.000
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex
Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min

Example 11

[0162] A fabric in Example 11 was obtained by repeating the procedure of Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 45 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (Trade Name of Technofine manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 30 filaments that was used as synthetic fiber multifilaments were fed and that the following conditions were employed.

①I nterlacing

[0163] Interlacing was conducted in the same manner as in Example 1.

②F alse Twisting

[0164]

False twisting heater: 170°C, set heater: not used
Twister belt cross angle: 102.5 degrees, twister belt contact pressure: 275 cN
Number of false twisting: 2191 t/m, stretch ratio: 1.000
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex
Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min

Example 12

[0165] A fabric in Example 12 was obtained by repeating the procedure of Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 45 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (Trade Name of Technofine manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 30 filaments that was used as synthetic fiber multifilaments were fed and that the following conditions were employed.

①I nterlacing

[0166] Interlacing was conducted in the same manner as in Example 1.

②F alse Twisting

[0167]

False twisting heater: 170°C, set heater: not used
Twister belt cross angle: 105 degrees, twister belt contact pressure: 275 cN
Number of false twisting: 2231 t/m, stretch ratio: 1.000
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex
Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min

Example 13

[0168] A fabric in Example 13 was obtained by repeating the procedure of Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 45 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (Trade Name of Technofine manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 30 filaments that was used as synthetic fiber multifilaments were fed and that the following conditions were employed.

①I nterlacing

[0169] Interlacing was conducted in the same manner as in Example 1.

②F alse Twisting

[0170]

False twisting heater: 170°C, set heater: not used
Twister belt cross angle: 107.5 degrees, twister belt contact pressure: 275 cN
Number of false twisting: 2270 t/m, stretch ratio: 1.000
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex
Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min

Example 14

[0171] W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co. Ltd.) with 83 dtex 30 filaments that was used as synthetic fiber multifilaments was fed to a friction false twisting machine of a belt nip type (trade name of 33H Mach Climper, manufactured by Murata Machinery Ltd.), and false twisted under the following conditions. A fabric in Example 14 was obtained by the same procedure as in Example 1 except that the false twisted synthetic fiber multifilaments and a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co. Ltd.) with 83 dtex 54 filaments that had been obtained by the net process and was used as cellulose multifilaments, were interlaced under the following conditions.

①F alse Twisting

[0172]

False twisting heater: 195°C, set heater: 175°C
Twister belt cross angle: 90 degrees, twister belt contact pressure: 196 cN
Number of false twisting: 2817 t/m, stretch ratio: 1.03
Twisting tension: 0.25 cN/dtex
Untwisting tension: 0.25 cN/dtex
Winding tension: 0.06 cN/dtex, texturizing speed: 400 m/min

②I nterlacing

[0173]

Interlacing nozzle: 1.5 mm in diameter, driving type (trade name of KC-AJI-L, manufactured by Kyocera Corporation)
Feed rate: cellulose multifilaments: 1.0%
synthetic fiber multifilaments: 3.0%
Air pressure: 1.5 x 10^5 Pa, texturizing speed: 300 m/min
Winding tension: 0.03 cN/dtex

Example 15

[0174] A fabric in Example 15 was obtained in the same manner as in Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 56 dtex 30 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co., Ltd.) with 56 dtex 30 filaments that was used as synthetic fiber multifilaments were fed and that the following conditions were employed.

①I nterlacing

[0175]

Interlacing nozzle: trade name of MK-2, manufactured by Awa Spindle K.K.
Feed rate: both type of multifilaments being overfed by 1.5%
Air pressure: 1.5 x 10^5 Pa, texturizing speed: 300 m/min

②F alse Twisting

[0176]

False twisting heater: 170°C, set heater: not used
Twister belt cross angle: 105 degrees, twister belt contact pressure: 225 cN
Number of false twisting: 2732 t/m, stretch ratio: 0.985
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex
Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min

Using the composite crimped yarn thus obtained that had a total size of 112 dtex, an interlock fabric texture was knitted with a 20-gauge double tubular knitting machine (number of needles: 1,360 for each bed) 53.3 cm (21 inches) in diameter. The knitted loop length was 0.49 cm/wale.

Example 16

[0177] A fabric in Example 16 was obtained in the same manner as in Example 15 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 56 dtex 30 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co., Ltd.) with 56 dtex 30 filaments that was used as synthetic fiber multifilaments were fed and that the following conditions were employed.

①I nterlacing

[0178] Interlacing was conducted in the same manner as in Example 15.

②F alse Twisting

[0179]

False twisting heater: 170°C, set heater: not used
Twister belt cross angle: 92.5 degrees, twister belt contact pressure: 225 cN
Number of false twisting: 2488 t/m, stretch ratio: 0.985
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex
Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min
Using the composite crimped yarn thus obtained, that had a total size of 112 dtex, a circular rib texture was knitted with a 20-gauge double tubular knitting machine (number of needles: 1,360 for each bed) 53.3 cm (21 inches) in diameter. The knitted loop length was 0.43 cm/wale.

Example 17

[0180] A fabric in Example 17 was obtained in the same manner as in Example 15 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co. Ltd.) with 33 dtex 24 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co., Ltd.) with 56 dtex 30 filaments that was used as synthetic fiber multifilaments were fed and that the following conditions were employed.

①I nterlacing

[0181] Interlacing was conducted in the same manner as in Example 15.

②F alse Twisting

[0182]

False twisting heater: 170°C, set heater: not used
Twister belt cross angle: 95 degrees, twister belt contact pressure: 225 cN
Number of false twisting: 2836 t/m, stretch ratio: 0.985
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex
Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min
Using the composite crimped yarn thus obtained that had a total size of 89 dtex, an interlock fabric texture was knitted with a 26-gauge double tubular knitting machine 50.8 cm (20 inches) in diameter. The knitted loop length was 0.44 cm/wale.

Example 18

[0183] A fabric in Example 18 was obtained in the same manner as in Example 17 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co. Ltd.) with 56 dtex 74 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co., Ltd.) with 33 dtex 18 filaments that was used as synthetic fiber multifilaments were fed.

Example 19

[0184] A composite crimped yarn having a total size of 89 dtex was obtained in the same manner as in Example 17 by feeding a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co. Ltd.) with 33 dtex 24 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co., Ltd.) with 56 dtex 30 filaments that was used as synthetic fiber multifilaments.

[0185] W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co., Ltd.) with 56 dtex 30 filaments was used as a warp yarn, and the composite crimped yarn with a total size of 89 dtex obtained above was used as a weft yarn; a woven fabric having a plain weave texture was prepared with a rapier loom. The woven fabric was bleached with a scouring agent and hydrogen peroxide at temperature from 80 to 90°C for 40 minutes, using a jet dyeing machine. The pH was adjusted, and the knitted fabric was washed with water, and boiled at 100°C for 20 minutes. The knitted fabric was then washed with water, dried, and steam set at 170°C for 1 minute to give a fabric in Example 19 having a warp density of 126 warps/2.54 cm and a weft density of 87 wefts/2.54 cm.

Comparative Example 1

[0186] A fabric in Comparative Example 1 was obtained by repeating the procedure of Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 22 dtex 12 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co., Ltd.) with 167 dtex 60 filaments that was used as synthetic fiber multifilaments were fed and that the following conditions were employed.

①I nterlacing

[0187] Interlacing was conducted in the same manner as in Example 1.

②F alse Twisting

[0188]

False twisting heater: 175°C, set heater: not used
Twister belt cross angle: 110 degrees, twister belt contact pressure: 275 cN
Number of false twisting: 2,170 t/m, stretch ratio: 1.003
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex
Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min
Using the thus obtained composite crimped yarn having a total size of 211 dtex, an 18-gauge circular rib texture was knitted with a double tubular knitting machine. The knitted loop length was 0.56 cm/wale.

Comparative Example 2

[0189] A fabric in Comparative Example 2 was obtained by repeating the procedure of Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 167 dtex 90 filaments that was used as cellulose multifilaments and round-shaped cross-sectional polyester (manufactured by Asahi Chemical Industry Co., Ltd.) with 22 dtex 6 filaments that was used as synthetic fiber multifilaments were fed and that the following conditions were employed.

①I nterlacing

[0190] Interlacing was conducted in the same manner as in Example 1.

②F alse Twisting

[0191]

False twisting heater: 175°C, set heater: not used
Twister belt cross angle: 110 degrees, twister belt contact pressure: 275 cN
Number of false twisting: 2,170 t/m, stretch ratio: 0.985
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex
Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min
Using the thus obtained composite crimped yarn having a total size of 211 dtex, an 18-gauge circular rib texture was knitted with a double tubular knitting machine. The knitted loop length was 0.56 cm/wale.

Comparative Example 3

[0192] A fabric in Comparative Example 3 was obtained by repeating the procedure in Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 12 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 30 filaments that was used as synthetic fiber multifilaments were fed.

Comparative Example 4

[0193] A fabric in Comparative Example 4 was obtained by repeating the procedure in Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 45 filaments that was used as cellulose multifilaments and round-shaped cross-sectional polyester (manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 12 filaments that was used as synthetic fiber multifilaments were fed.

Comparative Example 5

[0194] A fabric in Comparative Example 5 was obtained by repeating the procedure of Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 45 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 30 filaments that was used as synthetic fiber multifilaments were fed and that the following conditions were employed.

①I nterlacing

[0195] Interlacing was conducted in the same manner as in Example 1.

②F alse Twisting

[0196]

False twisting heater: 170°C, set heater: not used
Twister belt cross angle: 90 degrees, twister belt contact pressure: 275 cN
Number of false twisting: 1,992 t/m, stretch ratio: 1.000
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex
Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min.

Comparative Example 6

[0197] A fabric in Comparative Example 6 was obtained by repeating the procedure of Example 1 except that a cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 45 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (Trade name of Technofine, manufactured by Asahi Chemical Industry Co., Ltd.) with 83 dtex 30 filaments that was used as synthetic fiber multifilaments were fed and that the following conditions were employed.

①I nterlacing

[0198] Interlacing was conducted in the same manner as in Example 1.

②F alse Twisting

[0199]

False twisting heater: 170°C, set heater: not used
Twister belt cross angle: 110 degrees, twister belt contact pressure: 275 cN
Number of false twisting: 2,310 t/m, stretch ratio: 1.000
Twisting tension: 0.19 cN/dtex
Untwisting tension: 0.10 cN/dtex
Winding tension: 0.03 cN/dtex, texturizing speed: 300 m/min

Comparative Example 7

[0200] Two cuprammonium rayon yarns (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) each having 56 dtex 30 filaments were doubled, and knitted into an interlock texture using a 26-gauge tubular knitting machine. The knitted fabric was bleached with a scouring agent and hydrogen peroxide at temperature from 80 to 90°C for 40 minutes, using a jet dyeing machine. The pH was adjusted, and the knitted fabric was washed with water, and boiled at 100°C for 20 minutes. The knitted fabric was then washed with water, dried with a suction drum, and steam set to give a fabric in Comparative Example 7.

Comparative Example 8

[0201] W-shaped cross-sectional polyester (trade name of Technofine, manufactured by Asahi Chemical Industry Co. Ltd.) with 167 dtex 60 filaments was fed to a friction false twisting machine of belt nip type (trade name of 33H Mach Climper, manufactured by Murata Machinery Ltd.), and false twisted under the following conditions.

①F alse Twisting

[0202]

False twisting heater: 195°C, set heater: 175°C
Twister belt cross angle: 115 degrees, twister belt contact pressure: 275 cN
Number of false twisting: 2,388 t/m, stretch ratio: 1.03
Twisting tension: 0.25 cN/dtex
Untwisting tension: 0.25 cN/dtex
Winding tension: 0.06 cN/dtex, texturizing speed: 400 m/min

[0203] The false twisted yarn thus obtained was knitted into an interlock texture using a 20-gauge tubular knitting machine. The knitted fabric was bleached with a scouring agent and hydrogen peroxide at temperature from 80 to 90°C for 40 minutes, using a jet dyeing machine. The pH was adjusted, and the knitted fabric was washed with water, and boiled at 100°C for 20 minutes. The knitted fabric was then washed with water, dried with a suction drum, and steam set to give a fabric of Comparative Example 8.

Comparative Example 9

[0204] A cuprammonium rayon yarn (trade name of Bemberg, manufactured by Asahi Chemical Industry Co., Ltd.) with 33 dtex 24 filaments that was used as cellulose multifilaments and W-shaped cross-sectional polyester (Trade name of Technofine, manufactured by Asahi Chemical Industry Co., Ltd.) with 56 dtex 30 filaments that was used as synthetic fiber multifilaments were twisted at a rate of 300 times/m with a twister (trade name of DTB Machine, manufactured by Murata Machinery Ltd.) to give a composite texturized yarn. The yarn was knitted into an interlock texture with a 22-gauge tubular knitting machine.

[0205] The knitted fabric was bleached with a scouring agent and hydrogen peroxide at temperature from 80 to 90°C for 40 minutes, using a jet dyeing machine. The pH was adjusted, and the knitted fabric was washed with water, and boiled at 100°C for 20 minutes. The knitted fabric was then washed with water, dried with a suction drum, and steam

set to give a fabric of Comparative Example 9.

Comparative Example 10

[0206] A cotton yarn (number count: 40) was knitted into a circular rib fabric of Comparative Example 10 that was stiff to the touch.

[0207] The structures, evaluation results and the like of fabrics in examples and comparative examples are summarized in Tables 1 to 4.

[0208] In addition, abbreviations in Table 1 signify as follows:

Cmf: cellulose multifilaments
BB: cuprammonium rayon yarn (trade name of Bemberg)
W: W-shaped cross-sectional polyester
O: round-shaped cross-sectional polyester
X: method comprising first interlacing and then false twisting cellulose multifilaments and synthetic multifilaments
Y: method comprising false twisting synthetic fiber multifilaments and then interlacing the false twisted yarn and cellulose multifilaments
Z: method comprising union twisting both types of multifilaments

Table 1

	Cellulose multifilaments			Synthetic fiber multi-filaments			Combining compositing method	Cmf mixing ratio(%)
		dtex	fil		dtex	fit		
Ex. 1	BB	83	45	W	83	30	X	50
Ex. 2	BB	44	24	W	167	60	X	21
Ex. 3	BB	133	70	O	56	24	X	71
Ex. 4	BB	83	18	W	83	30	X	50
Ex. 5	BB	83	74	W	83	30	X	50
Ex. 6	BB	83	45	O	83	24	X	50
Ex. 7	BB	83	45	O	83	60	X	50
Ex. 8	BB	83	45	W	83	30	X	50
Ex. 9	BB	83	45	W	83	30	X	50
Ex. 10	BB	83	45	W	83	30	X	50
Ex. 11	BB	83	45	W	83	30	X	50
Ex. 12	BB	83	45	W	83	30	X	50
Ex. 13	BB	83	45	W	83	30	X	50
Ex. 14	BB	83	54	W	83	30	Y	50
Ex. 15	BB	56	30	W	56	30	X	50
Ex. 16	BB	56	30	W	56	30	X	50
Ex. 17	BB	33	24	W	56	30	X	38
Ex. 18	BB	56	74	W	33	18	X	63
Ex. 19	BB	33	24	W	56	30	X	38
C.E. 1	BB	22	12	W	167	60	X	12
C.E. 2	BB	167	90	O	22	6	X	88
C.E. 3	BB	83	12	W	83	30	X	50
C.E. 4	BB	83	45	O	83	12	X	50

Table 1 (continued)

	Cellulose multifilaments			Synthetic fiber multi-filaments			Combining compositing method	Cmf mixing ratio(%)
		dtex	fil		dtex	fit		
C.E. 5	BB	83	45	W	83	30	X	50
C.E. 6	BB	83	45	W	83	30	X	50
C.E. 7	BB	56	30	-	-	-	-	100
C.E. 8	-	-	-	W	167	60	-	0
C.E. 9	BB	33	24	W	56	30	Z	38
C.E. 10	cotton yarn, number count of 40						-	-

Table 2

	Total size dtex	Cmf single filament dtex	Synthetic fiber single filament dtex	Crimp stretch ratio %	Wet frictional coefficient	A %	Fabric texture	Mass of gray fabric g/m^2
Ex. 1	167	1.85	2.78	16	0.43	87	cic rib*	170
Ex. 2	211	1.85	2.78	24	0.31	56	cic rib*	210
Ex. 3	189	1.90	2.31	12	1.50	67	cic rib*	202
Ex. 4	167	4.63	2.78	16	0.42	83	cic rib*	170
Ex. 5	167	1.13	2.78	18	0.45	88	cic rib*	171
Ex. 6	167	1.85	3.47	16	0.47	82	cic rib*	170
Ex. 7	167	1.85	1.39	19	0.35	92	cic rib*	173
Ex. 8	167	1.85	2.78	5	2.60	69	cic rib*	166
Ex. 9	167	1.85	2.78	8.7	1.80	75	cic rib*	168
Ex. 10	167	1.85	2.78	10.5	0.80	83	cic rib*	170
Ex. 11	167	1.85	2.78	24.1	0.75	91	cic rib*	171
Ex. 12	167	1.85	2.78	27	0.73	92	cic rib*	173
Ex. 13	167	1.85	2.78	32.7	0.70	89	cic rib*	176
Ex. 14	167	1.54	2.78	14	1.70	74	cic rib*	177
Ex. 15	111	1.85	1.85	18	0.40	89	intlck+	145
Ex. 16	111	1.85	1.85	8.2	2.01	78	cic rib*	122
Ex. 17	88.9	1.39	1.85	17	1.40	71	intlck+	103
Ex. 18	88.9	0.75	1.85	13	1.48	73	intlck+	108
Ex. 19	88.9	1.39	1.85	15	2.80	70	wv fab**	111
C.E. 1	189	1.85	2.78	24	0.30	27	cic rib*	204
C.E. 2	189	1.85	3.70	11	3.10	29	cic rib*	215
C.E. 3	167	6.94	2.78	16	0.42	79	cic rib*	170

Note: * cic rib = circular rib
** wv fab = woven fabric
+ intlck = interlock

Table 2 (continued)

	Total size dtex	Cmf single filament dtex	Synthetic fiber single filament dtex	Crimp stretch ratio %	Wet frictional coefficient	A %	Fabric texture	Mass of gray fabric g/m^2
C.E. 4	167	1.85	6.94	16	0.50	80	cic rib*	170
C.E. 5	167	1.85	2.78	3.8	3.10	62	cic rib*	165
C.E. 6	167	1.85	2.78	41	0.38	88	cic rib*	177
C.E. 7	56	1.85	-	-	3.77	-	cic rib*	149
C.E. 8	167	-	2.78	37	0.30	-	intlck+	134
C.E. 9	88.9	1.39	1.85	-	5.78	25	intlck+	108
C.E. 10	150	-	-	-	2.62	-	cic rib*	124

Note: * cic rib = circular rib
+ intlck = interlock

Table 3

	Cool and refreshing feeling		Stretch stress (cN/cm)		Stretch recovery ratio (%)		Skin irritation index (μS)	
	SB	SN	Warp 50%	Weft 80%	Warp 50%	Weft 100%	During drying	During wetting
Ex. 1	1	1.4	11.0	13.0	88	87	7	15.1
Ex. 2	0	0.2	-	-	-	-	-	-
Ex. 3	0.7	1	-	-	-	-	-	-
Ex. 4	-	-	-	-	-	-	7.4	18
Ex. 5	- -	-	-	-	-	-	6.9	14
Ex. 6	-	-	-	-	-	-	7.0	19.1
Ex. 7	-	-	-	-	-	-	6	11
Ex. 8	1.5	0.5	20.0	20.0	81	81	6	19.3
Ex. 9	1.5	0.8	19.0	20.0	83	82	6	15.6
Ex. 10	1.4	1.1	14.0	15.0	85	86	6.7	15
Ex. 11	0.8	1.3	10.0	12.0	89	88	7.1	17.2
Ex. 12	0.6	1	9.0	12.0	90	89	7.4	18.3
Ex. 13	0.2	0.3	8.0	11.0	91	90	7.6	19.1
Ex. 14	1	1.2	12.7	14.7	82	83	7.1.	17.2
Ex. 15	1.1	1	9.8	11.8	89	87	6.8	13.0
Ex. 16	1.4	0.6	15.7	13.7	81	83	6.8	17.7
Ex. 17	1.3	0.8	7.8	11.8	91	94	6.3	15.8
Ex. 18	1.3	1	6.9	11.8	89	90	6.0	16.0
Ex. 19	0.7	0.5	-	-	-	-	7.7	19.8
C.E. 1	-0.5	0.2	-	-	-	-	-	-
C.E. 2	0.8	0.6	-	-	-	-	-	-
C.E. 3	-	-	-	-	-	-	10.8	20

Table 3 (continued)

	Cool and refreshing feeling		Stretch stress (cN/cm)		Stretch recovery ratio (%)		Skin irritation index (μS)	
	SB	SN	Warp 50%	Weft 80%	Warp 50%	Weft 100%	During drying	During wetting
C.E. 4	-	-	-	-	-	-	14	33
C.E. 5	1.5	0.3	22	25	78	78	5.8	23
C.E. 6	0	0.1	7	10	92	91	9.9	20.6
C.E. 7	1.1	0.5	20	19	77	79	5.7	21.2
C.E. 8	-1.2	0.3	7.0	10.0	93	94	11.3	25.0
C.E. 9	0.9	0.1	18.0	18.0	78	81	7.3	22.2
C.E. 10	0.1	0.4	22.6	24.5	73	80	10.8	30.0

Table 4

	Aesthetic appearance	Stickiness with sweat	Sweaty, sticky feeling	Cool and refreshing feeling	Heat retaining feeling	Touch	Skin irritation	Movability	Smoothness
Ex. 1	2.2	2.5	2.1	2.8	0.7	2	2.1	2.4	2.3
Ex. 2	1.8	2.6	0	-1	1	-	-	-	-
Ex. 3	2.2	1.9	2.3	2.2	0.4	-	-	-	-
Ex. 4	2.0	-	-	-	-	1.5	1	-	-
Ex. 5	2.3	-	-	-	-	2.1	2.3	-	-
Ex. 6	1.8	-	-	-	-	1.8	0.5	-	-
Ex. 7	2.3	-	-	-	-	2.6	2.6	-	-
Ex. 8	2.3	0.9	2.1	1.7	0	2	2.3	1.1	2.4
Ex. 9	2.3	1.7	2.2	2.3	0.3	2.1	2.3	1.8	2.3
Ex. 10	2.3	2.2	2.1	2.7	0.6	2.1	2.2	2	2.3
Ex. 11	2.3	2.6	2	2	0.8	1.9	1.9	2.5	1.4
Ex. 12	2.2	2.6	1.8	1.6	1.1	1	1	2.6	1.2
Ex. 13	2.0	2.6	1.5	0.9	1.1	0.6	0.6	2.7	0.5
Ex. 14	1.9	1.8	2.1	2.4	0.7	1.9	1.9	2.3	1.7
Ex. 15	2.6	2.4	2.3	2.3	0.7	2.2	2.3	2.5	2.4
Ex. 16	2.6	1	2.3	2.4	0.1	2.2	2	1.9	2.5
Ex. 17	2	2	2.3	2.1	0	2.4	2.4	2.6	2.5
Ex. 18	2.1	1.9	2.6	2.3	-0.1	2	2.4	2.5	2.5
Ex. 19	2	0.6	1.5	0.9	-0.8	1.3	1.5	0.2	1.9
C.E. 1	1.6	2.3	-1.7	-1.5	1.4	-	-	-	-
C.E. 2	2.3	-0.9	1.8	0.7	0	-	-	-	-
C.E. 3	1.8	-	-	-	-	0.4	-0.1	-	-
C.E. 4	1.4	-	-	-	-	0.3	-0.5	-	-
C.E. 5	2.4	-0.9	2.1	1.3	-0.5	2	1.9	0.5	2.4

Table 4 (continued)

	Aesthetic appearance	Stickiness with sweat	Sweaty, sticky feeling	Cool and refreshing feeling	Heat retaining feeling	Touch	Skin irritation	Movability	Smoothness
C.E. 6	1.7	2.6	1	0.3	1.2	0.5	-0.3	2.8	-0.1
C.E. 7	2.3	-1.9	1.5	1	-1.2	1.1	2.8	1.2	2.8
C.E. 8	1.6	2.2	-1.6	-1.4	1.5	0.5	0.2	2.9	-0.8
C.E. 9	1.1	-2.3	1.9	0.3	0.1	0.9	1	0.8	0.5
C.E.10	-1.5	-0.9	-0.8	-2.1	1.4	0.3	0.5	0.4	-0.7

[0209] Furthermore, these fabrics were sewed by a conventional method of sewing undergarments to form undergarments (shirts with half-length sleeves, T-shirts). Wearing tests were conducted on five male panelists aged between twenty and forty for about 18 months (from April to September next year). The following were evaluated on the basis of 7 grades from -3 to 3 (seven grade evaluation method): beautiful appearance (aesthetic appearance); stickiness with sweat during wearing; sweaty, sticky feeling; cool and refreshing feeling; heat retaining feeling; touch; skin irritation; movability; and smoothness. The average values are shown in Table 4. In addition, a larger evaluated value shows that the undergarment is more excellent.

[0210] Wearing tests were conducted in a combination of Examples 1 to 3 and Comparative Examples 1 to 2, a combination of Examples 1 and 4 to 7 and Comparative Examples 5 to 6, and a combination of Examples 1 and 13 to 27 and Comparative Examples 5 to 10. The level of each test was made to be consistent with that in Example 1.

[0211] Undergarments prepared from the fabrics in Examples 1, 13 to 27 each showed no stickiness during wearer's perspiration, no sweaty-sticky feeling, excellent stretchability and movability, excellent smoothness and a nonsticky touch, gave neither an itchy feeling nor an unfamiliar feeling regardless of a change in the season during the test, and had a soft and lustrous appearance. and a refined touch of high quality.

[0212] Undergarments prepared from the fabrics in Examples 2 to 3 did not become sticky with sweat, and gave a comfortable feeling. Moreover, undergarments prepared from the fabrics in Examples 6 to 12 each had an excellent touch, and gave neither an itchy feeling nor an unfamiliar feeling regardless of a change in the season during the test.

[0213] On the other hand, undergarments prepared from a fabric in Comparative Example 1 has sweaty, sticky feeling, and gave no cool and refreshing feeling and had an uncomfortable feeling. Undergarments prepared from a fabric in Comparative Example 2 were sticky with sweat, and gave a very uncomfortable feeling. Undergarments prepared from fabrics in Comparative Examples 3, 4 and 6 gave skin irritation to some of the panelists. Undergarments prepared from fabrics in Comparative Examples 5, 7, 9 and 10 gave a very uncomfortable feeling when the wearers perspired because the undergarments became sticky with sweat. Undergarments prepared from a fabric in Comparative Example 8 has much sweaty, sticky feeling and gave a hot feeling and had a very uncomfortable feeling.

Industrial Applicability

[0214] When the fabric of the present invention is used for applications in direct contact with skin, for example, when it is used for garments, they show excellent sweat absorbability, give neither a sticky feeling nor cling to the skin even if the wearers perspire much in their daily life, have less sweaty-sticky feeling due to the excellent moisture absorbability, produce a cool and refreshing feeling even on a hot summer day, and are soft and warm to the touch even on a cold winter day. Moreover, the fabric is excellent in stretchability and smoothness so that the wearers have no constrained feeling and a wearable feeling during their movement. The fabric is soft to the touch, and produces less physical frictional irritation on the skin. Moreover, the fabric is gentle to the skin and can maintain an aesthetic appearance the filaments have even when continuously worn.

[0215] Accordingly, the fabric of the present invention is appropriate for products such as garments which are worn directly on the skin, bedding, towels and handkerchiefs. In particular, undergarments for which the fabric of the present invention is used are excellent for women, and they also satisfactorily function for men.

Claims

1. A fabric to be worn directly on the skin comprising knitted or woven fabric obtained by knitting or weaving a composite crimped yarn prepared by combining cellulose multifilaments and synthetic fiber multifilaments at least one of which are false twisted, and satisfying the following requirements (a) to (e):

   (a) the mixing ratio of the cellulose multifilaments in the composite crimped yarn is from 15 to 85% by weight;
   (b) the total size of the composite crimped yarn is from 44 to 333 dtex;
   (c) the single filament size of the cellulose multifilaments is from 0.1 to 5.6 dtex;
   (d) the single filament size of the synthetic fiber multifilaments is from 0.1 to 5.6 dtex; and
   (e) the crimp stretchability of the composite crimped yarn is greater than 4.0% and 35% or less.

2. The fabric according to claim 1, wherein the crimp stretchability of the composite crimped yarn is from 8.0 to 25%.

3. The fabric according to claim 1 or 2, wherein the knitted or woven fabric shows a wet frictional coefficient of 3.0% or less.

4. The fabric according to any one of claims 1 to 3, wherein the ratio (A) of S to SG is from 30 to 95%, wherein S is

the area of the duplicating region of the dispersion region of the single filaments in the cellulose multifilaments and the dispersion region of the single filaments in the synthetic fiber multifilaments, and SG is the area of the dispersion region of single filaments in the synthetic fiber multifilaments.

5. The fabric according to any one of claims 1 to 4, wherein SB that is defined by the formula (2) and that is a measure of a cool and refreshing feeling in a slightly sweaty environment of the knitted or woven fabric satisfies the formula (1), and SN that is defined by the formula (4), which is a measure of a cool and refreshing feeling when the wearer perspires, satisfies the formula (3):

$$0.0 < SB < 100.0 \quad (1)$$

$$SB = 1.08 \times (\text{heat dissipation amount}) + 1.98 \times (\text{surface unevenness}) + 6.25 \times (\text{surface frictional coefficient}) - 13.92 \quad (2)$$

$$0.0 < SN < 100.0 \quad (3)$$

$$SN = -0.03 \times (\text{water transport amount}) + 1.42 \times (\text{moisture transfer degree}) + 0.17 \times (\text{heat dissipation amount}) + 0.76 \times (\text{surface unevenness}) + 12.1 \times (\text{surface frictional coefficient}) - 16.6 \quad (4)$$

6. The fabric according to any one of claims 1 to 5, wherein the knitted or woven fabric shows a skin irritation index of 8.0 μS or less during drying.

7. The fabric according to any one of claims 1 to 6, wherein the stretch stress of the knitted fabric in the warp direction during stretching by 50% and the stretch stress thereof in the weft direction during stretching by 80% are 20 cN/cm width or less, and the stretch recovery ratio of the knitted fabric in the warp direction during stretching by 50% and the stretch recovery ratio thereof in the weft direction during stretching by 100% are 80% or more.

8. The fabric according to any one of claims 1 to 7, wherein the knitted fabric is composed of an interlock texture having a mass per unit area of 80 to 250 g/m^2, and the loop length L (cm) of stitches forming the knitted fabric and the total size D (dtex) of the composite crimped yarn satisfy the formula (5):

$$2.9\ (\text{cm}) \leqq (L/D^{1/2}) \times 100 \quad (5)$$

9. The fabric according to any one of claims 1 to 7, wherein the knitted fabric is composed of a circular rib texture having a mass per unit area from 80 to 250 g/m^2, and the loop length L (cm) of stitches forming the knitted fabric and the total size D (dtex) of the composite crimped yarn satisfy the formula (6):

$$2.1\ (\text{cm}) \leqq (L/D^{1/2}) \times 100 \quad (6)$$

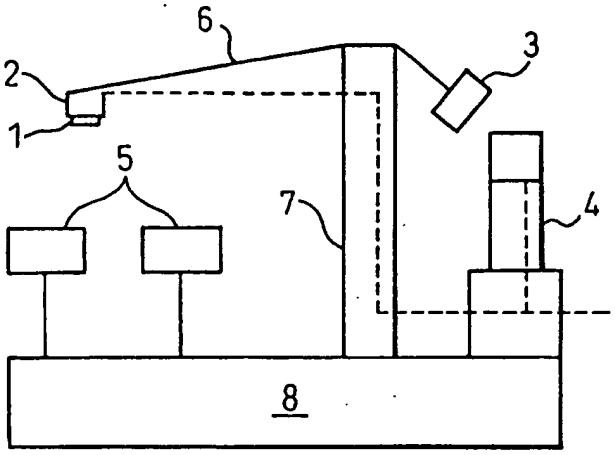
10. The fabric according to any one of claims 1 to 7, wherein the knitted fabric is composed of a gray sheeting texture having a mass per unit area from 80 to 250 g/m^2, and the loop length L (cm) of stitches forming the knitted fabric and the total size D (dtex) of the composite crimped yarn satisfy the formula (7):

$$2.1\ (cm) \leqq (L/D^{1/2}) \times 100 \qquad (7)$$

11. A fabric product in which the fabric according to any one of claims 1 to 10 is entirely or partly used for a garment, bedding, a towel or a handkerchief.

12. An undergarment for which the fabric according to any one of claims 1 to 10 is entirely or partly used.

Fig.1



INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] D03D15/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] D03D1/00-15/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Toroku Jitsuyo Shinan Koho	1994-2000
Kokai Jitsuyo Shinan Koho	1971-2000	Jitsuyo Shinan Koho	1996-2000

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP, 9-3740, A (Asahi Chemical Industry Co., Ltd.), 07 January, 1997 (07.01.97), Full text, (Family: none)	1-12
A	JP, 61-6351, A (UNITIKA Ltd.), 13 January, 1986 (13.01.86), Full text, (Family: none)	8
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No.53461/1980 (Laid-open No.156884/1981) (Kitabatake Meriyasu Kabushiki Kaisha), 24 November, 1981 (24.11.81) (Family: none)	9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 25 July, 2000 (25.07.00)	Date of mailing of the international search report 01 August, 2000 (01.08.00)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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